Pricing Strategies in Online & Offline Retailing

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Abstract

The thesis deals with pricing strategies for multichannel retailers, especially traditional stores which additionally manage an online shop. The problem of integrating two sales channels and applying a well-suited pricing strategy is still an emergent question. This work develops a stochastic model to represent consumer behavior on pricing. On the one hand the model contains two probability functions which render consumers' reservation prices for each individual channel. On the other hand the stochastic model is based on numerous distributions which represent switching probabilities from and to each separate channel. The various distribution functions will be estimated from the results of a survey. To highlight differences of pricing strategies due to several product categories a cross comparisons of books, clothes and digital cameras will be presented.

The results show that there are differences in multichannel pricing of the various products. These inequalities stem from consumers' perceptions of the sales channels. For each product a separate sales channel is preferred by consumers. Therefore, one channel exhibits some advantage versus the alternative channels. This advantage is reflected in different pricing strategies. Further appropriate marketing strategies could help a firm to counter discounting by its competitors. So firms should keep an eye on the reservation price structure of its consumers as well as their demanded marketing activities.

Zusammenfassung

Diese Arbeit beschäftigt sich mit der Preispolitik im Mehrkanalvertrieb, im Speziellen werden traditionelle Ladengeschäfte die auch einen Onlineshop betreiben untersucht. Die Integration mehrerer Vertriebskanäle und die Realisierung einer entsprechenden Preisstrategie stellt noch immer eine kritische Frage dar. In dieser Arbeit wird ein stochastisches Modell entwickelt, dass das Einkaufsverhalten der Konsumenten darstellt. Das Modell besteht aus zwei Wahrscheinlichkeitsfunktionen, die die Reservationspreise der Konsumenten in jedem Vertriebskanal repräsentieren. Ferner basiert das Modell auf mehreren Wahrscheinlichkeitsfunktionen, die die Wechselwahrscheinlichkeiten zwischen den verschiedenen Kanälen darstellen. Die unterschiedlichen Wahrscheinlichkeiten werden mithilfe einer Umfrage geschätzt. Differenzen in der Preispolitik werden anhand von Büchern, Kleidung und Digitalkameras erschlossen.
Die Unterschiede in der Preispolitik stammen von unterschiedlichen Wahrnehmungen der Vertriebskanäle durch die Konsumenten. Für jedes Produkt wird ein anderer Kanal von den Konsumenten bevorzugt. Diese Vorliebe ermöglicht unterschiedlichen Preisstrategien. Des Weiteren kann durch eine angepasste Marketingstrategie besser auf Preisattacken von Mitbewerbern reagiert werden. Daher sollten Unternehmen sowohl die Reservationspreise ihrer Kunden beobachten als auch deren geforderten Marketinghandlungen anbieten.

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Gottfried Gruber, Fall 2008

Its not that I am so smart.
Its just that I stay with problems longer.

(Albert Einstein)

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Chapter 1

Introduction

Pricing decisions are becoming more and more relevant. Higher pressure from competitors and better informed consumers[1] are some ingredients which demand better and faster pricing decisions (Monroe and Bitta 1978). Further, pricing is known to have the deepest impact of all marketing activities a firm could conduct (Simon 1992). With the approach of the new sales channel via the Internet decisions may not become easier for firms doing business in both channels. Today online marketing is becoming more and more important. In some industries it has already become a “must have” feature. An additional online sales channel possibly reduces costs in various ways. Some authors argue that firms can add information to online offerings at low costs and thus achieve costs savings of up to 25 %, others state that firms could conduct channel integration to save operational costs (e.g., Alba et al. 1997, Adelaar et al. 2004). The unique features of the online channel allow firms to expand their offerings in a cheap way, which thereby help to serve consumers’ needs better, and thus increase profits (e.g., Alba et al. 1997). Furthermore, since menu costs are considerably low, firms are able to change prices more frequently and to a much finer extent than in their traditional channel. This price segmentation allows skimming consumer surplus better (e.g., Lee and Gosain 2002). Furthermore, the online channel may lower transaction costs (e.g., Ward 2001, Liang and Huang 1998).

[1] Both genders are attributed by consumers. For better readability, in the remainder of the work gender neutral notations will be omitted.

Through the online channel new consumer groups could be accessed (e.g., Baye and Morgan 2001). Recent literature asserts that an additional online channel increases market coverage and thereby the firm's profit (e.g., Friedman and Furey 2003, Bakos et al. 2005). Other studies highlight the demand-expanding capacity of the online channel (e.g., Berman and Thelen 2004, Geyskens et al. 2002). Positive effects are also attributed to the presumption that the online channel strengthens relationships to existing consumers, and the firm receives a loyalty payoff from maintaining its online channel. Evidence from the travel industry and even from the outdoor industry show the profitableness of using the online medium to reinforce loyalty (e.g., Shankar et al. 2003, Wallace et al. 2004).

Consumers may also obtain additional services by the online channel. Thereby they may be more satisfied which in turn leads to increased loyalty. With the use of an adapted time allocation model it is possible to display that multichannel retailers could indeed serve consumers' needs better and thus reduce harmful switching loss (e.g., Reardon and McCorkle 2002). Another study shows that loyalty could be leveraged if the firm is capable to put more weight on non-digital attributes of a product, which turn out to be highly relevant for the subsequent purchase decision (e.g., Lal and Sarvary 1999). Evidence for loyal consumers being less price sensitive was found to be also prevalent in the coffee market (e.g., Krishnamurthi and Raj 1991).

Additionally there exist considerations that a firm may extract synergies from an additional online sales channel (e.g., Berman and Thelen 2004, Adelaar et al. 2004, Steinfield et al. 2002). Since each channel provides different advantages, consumers tend to choose the optimal channel for their purchase. An additional channel therefore increases consumer fit and for this reason a firm's profit (e.g., Fox et al. 2004, Wikström 2005, Schoenbachler and Gordon 2002). A spatial model shows that an information provider is able to increase profits by supplementing the direct channel by an alternative indirect channel (e.g., Dewan et al. 2000). Thus, consumer value could be enhanced by serving their needs better (e.g., Berman and Thelen 2004, Adelaar et al. 2004, Sullivan and Thomas 2004).

From the marketing perspective, an online channel provides closer customer contact, which could be used for precise consumer profiling (e.g., Tsay and Agrawal 2004, Lee and Gosain 2002).

The Internet is often described as a “friction free” market (e.g., Bakos 2001). Increased competition should result in lower prices and less price dispersion. Furthermore, the distinctive features of the Internet, most notably reduced search costs, should increase price sensitivity. All together the friction free market should increase efficiency such that total welfare rises (e.g., Bakos 2001, Alba et al. 1997, Bakos et al. 2005).

But despite these advantages many practitioners believe in a threat from the friction free market. Indeed, reduced search costs encourage price competition, which firms try to prevent by introducing barriers (e.g., Alba et al. 1997, Odlyzko 1996, Bakos 1997, Salop 1979).

Thus, the fear of cannibalization seems to be well grounded. Cannibalization determines sales shifts from an entrenched channel to a new established online channel, which may not increase profits, but rather decrease them (e.g., Alba et al. 1997, Blattberg and Wisniewski 1989, Meredith and Maki 2001, Srinivasan et al. 2005, Steinfield et al. 2002, Hansen and Madlberger 2006). Further, cannibalization will be more likely, the higher the perceived similarity between products (e.g., Harvey and Kerin 1979). Especially the Internet sales channel offering digital information goods is exposed to cannibalization. Some authors state that issues like cannibalization, channel coordination and channel conflicts may be more pronounced due to the nature of the Internet (e.g., Balasubramanian 1998). Even worse, the online channel may not necessarily enhance consumer spending, partly due to a lack of cross-selling potential (e.g., Sullivan and Thomas 2004).

The newspaper and the music CDs industry both indicate signs of cannibalization, and it was confined that cannibalization may increase as the Internet becomes more mature (e.g., Deleersnyder et al. 2002, Biyalogorsky and Naik 2003). Additional studies reveal figures of cannibalization and decreasing returns on consumer durable and apparel products (e.g., Ansari et al. 2005). Especially homogeneous goods, in particular digital information goods, force firms to compete fiercely on prices because they contain no other differentiation feature. The unique features of digital information goods make particularly these firms very exposed to cannibalization (e.g., Bailey 1998, Shapiro and Varian 1999).

However, the online sales channel is not only a threat, it may also be a chance. Some studies even argue that there exists no cannibalization effect since online search generates offline sales (e.g., Ward 2001). But if the online sales channel becomes attractive, pricing strategies for this channel should also become relevant. Therefore, a proper pricing strategy is vital for firms doing business through different sales channels with homogeneous goods, since the price is closely related to the profit of a firm. A wrong pricing policy could harm a firm's profit or even drive it to bankruptcy. Wrong pricing causes deadweight loss. Deadweight loss denominates loss which could have been avoided by a proper allocation of resources, i.e. in this case an optimal pricing in both sales channels. First, deadweight loss occurs because too high a price lets some consumers forgo a purchase which would otherwise have taken place and thus lowers a firm's profit. Second, a price too low would bring many consumers, but ceteris paribus due to low prices the profit would not be adequate. Therefore, optimal pricing strategies are the passport to maximizing profit in industries which sell homogeneous products on the Internet as well as through traditional channels (e.g., Varian 1995, Shapiro and Varian 1999, Liebowitz 2002, Skiera 2000). In general the price is always an important competitive issue in satisfying consumers (e.g., Wallace et al. 2004).

This work wants to support firms which operate an online and an offline sales channel with normative guidance for their pricing decisions. Since price is just one aspect of the whole marketing mix (e.g., Kotler 2006) the other issues will also be covered.

The price a firm should charge in each channel denotes the main question of the current thesis. From differences in reservation prices of each channel different pricing strategies may emerge. Further, the product category may influence the reservation prices for each channel. Therefore, a second question asks what differences arise on the sale of various product categories. Does the product category influence prevalent pricing strategies? One could imagine that, e.g. purchasing shampoo will be different from purchasing digital cameras. But what is the influence of the differences on pricing.

Since pricing could be seen as the most important tool for marketers, these might be the most important questions for firms doing business online and through traditional stores. A firm aware of the impacts its marketing mix exerts on its consumers will be able to utilize this knowledge. Through a clever pricing policy accompanied by supportive investments in promotion and distribution the firm may attain competitive advantages, which should result in higher sales and profit for a firm.

But consumers will also profit from a firm knowing their needs. Consumers will feel safer, and more comfortable doing business with such a firm. Negative experiences will be reduced and finally consumers may be more satisfied overall.

The proposed model will cover reservation prices and switching probabilities from one channel to another, and how firms are able to influence migration. It is a theoretical model but has foundations in an empirical survey. The model should end in a simulation tool for multichannel retailers to obtain computer-assisted optimal pricing strategies, which maximize profits. According to the pricing strategies the management should also receive suggestions for optimally allocating pecuniary resources on determinants of distribution and promotion. Starting with a simple market model, suggestions for the management should be deduced. Stochastic simulations will be used to search for profit maximizing prices at different market conditions. In a pari passu manner, decisive parameters will be changed to cover some specific market conditions, derive an optimal pricing behavior and the impact of deviating from profit maximizing pricing.

The rationale for such a model is that market studies have some limitations. Inevitably they could harm a firm's business. In reality it is dangerous to play around with prices to measure different effects. Thus, we propose a model to quantify cannibalization and to assist firms with pricing suggestions and associated supportive distribution and promotion investments in a laboratory-like environment.

However, this work may be just a starting point because pricing is influenced by many more parameters. Thus, pricing still remains an inexact science with numerous random variables.

Chapter 2

Literature Review

In the early days pricing was composed solely of strict calculations. These calculations were only based on information about costs. Nowadays things have become different. Pricing has grown to be a crucial management decision which involves more than just the cost structure of the assembly process and the raw materials, so called cost-plus pricing (e.g., Diller 2003, p. 458).
But this does not mean that pricing was not important in the old days. The opposite turns out to be true. Pricing is and was always an important issue (e.g., Udell 1964). The impact of pricing on a manager's decision process is still enormous (Simon 1992). Especially pricing in the Internet receives growing attention as this market promises higher returns. Various pricing strategies and tools may also facilitate benefits for both sellers and buyers (Simon 1992, Hanson and Hansson 1999, Brandtweiner 2001). It seems obvious that pricing may mark the focus of most marketing strategies. Finally, the price determines crucially whether a product will be bought, or if it will be bought the remaining question is where to buy, which is also determined by the price.
Numerous authors are concerned about required price changes for doing business on the Internet sales channel. Many studies investigate the price level, the price elasticity and price dispersion. These factors define a price structure in a market as a whole. By knowing these factors firms were thought to be able to offer more appropriate prices and enhance profits. Unfortunately the findings on price levels,

variances and elasticities are ambiguous. The remaining solid statement is that pricing in the Internet should be done very similarly to pricing in traditional stores. Further, the Internet allows firms to implement new pricing strategies. The potential pricing strategies range from traditional posted prices to highly sophisticated yield management. Firms may implement different strategies to avoid the bitter competition. Therefore, dynamic strategies are useful to cover prices and make the market more opaque. Interactivity allows applying pricing strategies with user interaction like auctions. Finally, negligible price tagging costs allow firms to calculate each price for a consumer individually almost like with yield management. All these strategies are used to minimize competition and differentiate from competitors.

Costs, especially search costs and transaction costs, determine additional differences to traditional markets (e.g., Geyskens et al. 2002, Reynolds 2002). Costs still are an important ingredient for pricing. These costs directly influence consumers' reservation prices and their willingness to pay. Especially in the Internet, where the competitor is just one click away, search costs play a tremendous role.

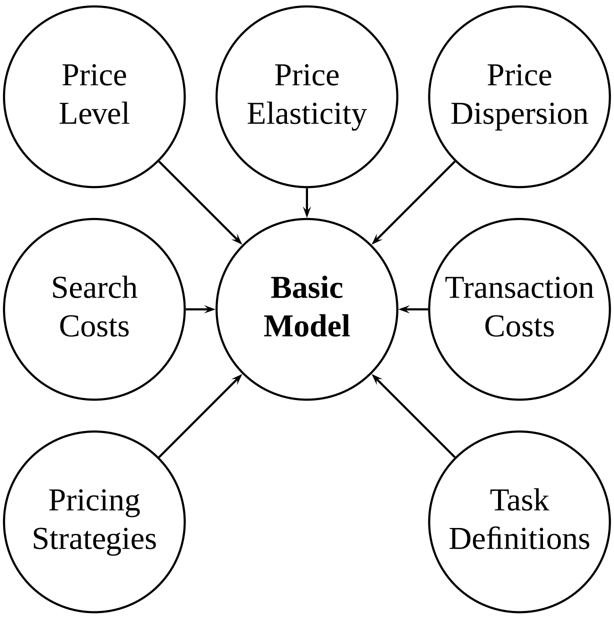

Figure 2.1: Influences on the Basic Model

Figure 2.1 depicts the most relevant influences on the basic model. Each specific topic will be covered in detail in the following sections.

2.1 Price Levels

Increased price competition should, by standard economic argument, drive prices down (e.g., Brynjolfsson and Kahin 2000). Since the Internet is assumed to encourage competition this reasoning seems plausible (e.g., Alba et al. 1997). For example, price comparison sites quote consumers a detailed overview on offerings. Brynjolfsson and Smith (2000) also states that due to lower supply costs, higher price competition and therefore the removal of physical monopolies, prices should decrease online. Numerous studies show that prices are distinctively lower in the online channel than in the offline channel. Especially digital information goods are found to have lower prices in the online channels, since they contain no additional differentiation feature and thus price competition may be enforced (Pan et al. 2002a, Lee and Gosain 2002, Ancarani and Shankar 2004). Even in the car retailing industry the Internet is capable to lower prices for new cars (Zettelmeyer et al. 2006). This is not surprising. The Internet offers full information and therefore allows consumers to come up with the most economic decision. Even more, software robots and price comparison sites provide convenient ways to find the minimal price quickly. Thus, the price is indeed the dominant attribute to attract consumers to an online shop (e.g., Reibstein 2002). Therefore, the well informed consumer is able to pick the lowest price at minimal effort or costs. The result is that higher competition combined with better informed consumers may be the foundation of declining prices in the online environment.

Interestingly, findings of higher prices in the Internet are also prevalent. Against intuition prices in the online channel may be higher due to differentiation, which increases equilibrium prices (Kuksov 2004). In eBay auctions, trusted sellers could obtain a premium compared to sellers with many negative ratings (Ba and Pavlou 2002). It is important to note that lower prices do not coincide with higher price sensitivity. Alba et al. (1997) argue in the opposite direction. Online consumers show higher loyalty, which decreases price sensitivity, and therefore higher online prices are obtainable. In a similar vein, Lynch and Ariely

(2000) state that non-price attributes may be valued by consumers. Especially convenience is worth some additional markup. For some products, where quality attributes become more stringent, price also plays a lesser role in the purchase decision and higher prices may be viable. Above all there exists also empirical evidence of higher prices for certain products in the online channel, indicating consumers' willingness to pay a premium for convenience (Bailey 1998, Ho-Guen 1998). An alternative interpretation may be given concerning the maturity of the Internet. If the reach of the Internet is small, we will observe high prices, but as soon as the Internet becomes more and more mature online prices will fall. However, there will be no discount to offline prices in a world with a mature Internet (Zettelmeyer 2000). In the same direction goes the argument that well adopted products have lower prices online, but not well adopted products display higher prices in the online channel (Balasubramanian 1998).

Ambiguous results on the price level in the online channel may indicate that price levels are determined by the maturity of the Internet, the adoption of a certain product for selling through the Internet, the information strategy of the firms and the competitiveness of the market. This ambiguity does not help firms to develop secure strategies for multichannel retailing. The proposed model should give some hints for pricing under different circumstances.

2.2 Price Elasticity

Price elasticity describes consumers' reactions on marginal price changes. Against common knowledge, online consumers seem to be less price sensitive than offline consumers (Degeratu et al. 2000). A number of studies found that improvements in quality and service will lower online consumers' price sensitivity even below offline consumers' price sensitivity (Alba et al. 1997, Shankar et al. 1999). Lynch and Ariely (2000) found also less price sensitivity online if competing shops offer a non-overlapping assortment. They even argue that increased transparency, i.e. easier price comparison, fast and appropriate information, will not increases price sensitivity. Well established brands can also help to lower price sensitivity. Danaher et al. (2003) state that online shoppers may prefer

known brand to avoid risks. Therefore, higher brand loyalty was observed, which reduced price sensitivity.
In contrast, transparency in the online sales channel would cause consumers to be more price sensitive in the online channel than in the offline channel. This may usually happen if the assortment of the shops is very similar and therefore consumers tend to choose the cheaper shop (e.g., Lynch and Ariely 2000). Theoretical studies as well as empirical studies on tax rates and groceries all claim increased price sensitivity of online consumers (Goolsbee 2000, Burke et al. 1992).
It seems that price elasticity is strongly determined by the product class. Homogeneous products will show higher price elasticity compared to products which can be differentiated by their features. This asymmetry may also be the outcome of different search frictions. A second impact may stem from overlapping assortments. The higher the overlap the higher consumers' price elasticity may be.

2.3 Price Dispersion

Price dispersion is an indicator of the competitiveness of a market. Higher price dispersion in the online channel than in the offline channel indicates that firms could avoid price competition by differentiating themselves with quality or service. Existing literature gives evidence for substantial price dispersion in the online channel for traveling agents, retailers in the books and CDs market and other products (Bailey 1998, Brynjolfsson and Smith 2000). Online traveling agencies have to differentiate themselves from each other by specializing and offering individual prices to its customers. Those strategies bring a wide range of prices and therefore high price dispersion. Clearly, the agencies try to avoid comparison and competition (e.g., Clemons et al. 2002). Ancarani and Shankar (2004) investigated books and CDs and found also higher price dispersion online than offline. For pure online retailers they show a 4 % wider price range than with traditional stores. Comparable results were also found by other authors (e.g., Iyer and Pazgal 2003, Baye and Morgan 2001).
On the opposite end are findings of lower price dispersion online, which imply higher price competition in this sales channel (e.g., Wernerfelt 1994, Morton et al. 2001). Less price dispersion in the online channel than in the offline channel was

found by studies on the car retail industry, CDs, DVDs, hardware, software and consumer electronics (e.g., Fang-Fang and Xing 2001, Pan et al. 2002b). Morton et al. (2001) for example found online consumers to be more informed about the current price structure and therefore online prices have to be less dispersed. Price comparison sites foster such a development. Even life insurance displays less price dispersion due to online price comparison sites (e.g., Brown and Goolsbee 2002).

Overall there seems to be no clear assertion concerning price dispersion. Some authors argue that price dispersion depends on the number of firms filling a certain market (e.g., Baye et al. 2004).

It might be that price dispersion is a function of the product class, the number of firms in that market and the competitiveness of that market, as well as the brand strength of the incumbent firms.

2.4 Search Costs

Search costs became an economic topic since the seminal work of Stigler (1961). For the Internet it emerges also as an important topic because search costs are assumed to decrease with the adoption of the Internet. The Internet encourages consumers to undertake unimpeded search across stores (Alba et al. 1997). Reduced search costs may result in increased competition and thereby in reduced prices (Bakos 2001, 1997). Further, increased competition makes it harder for firms to generate profits (Liebowitz 2002). Because of this, firms use brands to increase search costs and prevent price competition (Bergen et al. 1996).

However, lower search costs also allow firms to better monitor their competitors. This may foster collusion which increases firms' revenues (Campbell et al. 2005). Further, firms may provide better consumer fit, since lower search costs may help firms to identify qualified consumers. The Internet enables even profiling and monitoring back such strategies for evaluation (Bakos 2001, Lee and Gosain 2002).

Nevertheless online search costs may be not trivial (Lynch and Ariely 2000). Even if prices could easily be found, perceived search costs may be significant. Search costs of zero would imply unreasonable consideration sets for consumers, i.e. consumers' consideration sets may be overestimated frequently (Mehta et al. 2003). Further, there may exist an asymmetric search behavior. If search costs are lowest, consumers tend to search too little and vice versa (Zwick et al. 2003). Thus, consumers indeed do not always search for the lowest price (Smith and Brynjolfsson 2001). Empirical evidence highlights this phenomenon. Results show households visiting on average 1.2 book sites and 1.3 CD sites prior to their purchase decision (Johnson et al. 2004). Such behavior explains excess prices and profits of firms, if search costs become relevant, especially for low price products like books and CDs (Lal and Sarvary 1999). Further, consumers also have to evaluate a trade-off between benefits of higher accuracy and costs of more time spent on searching and expended cognitive effort. This trade-off may also lead to non-optimal decisions, i.e. consumers may not pick the store offering the lowest price. Search effort is not without costs (e.g., Morwitz et al. 1998, Verhoef et al. 2007).

2.5 Transactions Costs

Information technology, especially the emergence of the Internet, has increased in efficiency, which in turn reduces transaction costs (e.g., Bakos 1997, Alba et al. 1997, Bakos 1998, Litan and Rivlin 2001). Foremost, coordination between buyers and sellers as well as coordination within the firm are affected in a positive way by increased efficiency (Williamson 1981, Benjamin and Wigand 1995).

Transaction costs may be a competitive ability to firms, since consumers decide purchases upon transaction costs (e.g., Benjamin and Wigand 1995, Baye and Morgan 2001).

But firms should keep in mind that transactions costs may not only be perceived as costs by consumers. Chircu and Mahajan (2006) mention that traditional search and evaluation costs may create shopping entertainment. A firm reducing such costs may not benefit from this action.

Transaction costs may be related to the product class. Some products may display prohibitive transaction costs (e.g., cement), other services may need personal contact, which makes them not suitable for selling through the online channel (e.g., medical certificates). On the other hand digital information goods may be perfectly suited for the online channel, because they allow a direct delivery through the Internet. This delivery may be conducted instantaneously and at almost zero costs (e.g., Bakos 1998). Consumers tend to minimize transaction costs. Especially high frequency buyers could be expected to optimize their transactions. Firms guiding and supporting their consumers' demand may profit by differentiating from competitors and fostering loyalty (e.g., Kumar and Venkatesan 2005). Firms also may tend to minimize their transaction costs. As a natural fact, firms may choose that channel for a certain transaction, which may reduce the costs (Benjamin and Wigand 1995).

2.6 Pricing Strategies

The Internet allows firms to reach individual consumers and to customize pricing by direct marketing (Chen and Iyer 2002). By this means firms are able to realize complex pricing strategies. These strategies can even be modified at will in a short time. Moreover, digital information goods could be varied in manifold ways which promotes price differentiation. Interactivity in the end allows for auctions to be realized in the Internet.

Thus, the range of possible pricing strategies reaches from well known posted prices to sophisticated yield management. Each pricing strategy has its own advantages or disadvantages and there is no clear recommendation which strategy to use in conjunction with a certain product or a certain market environment.

Posted prices represent the widespread form to price products in the developed countries. Since there is no haggling about the price the transaction turns out to be cheap, clear and fast. All three factors are relevant in our developed world. Thus, posted prices show to be extremely efficient and functional (e.g., Liebowitz 2002). The most often used computation to calculate this kind of price is cost-plus computation. Therefore, the final price of a product results from unit costs plus a certain markup. Cost-plus pricing is by far the most common pricing strategy because of its simple calculation and its foundations on the costs. Applying such a strategy, managers stay in the safe haven, especially with regard to accounting departments (e.g., Noble and Gruca 1999, Simon 1992). Although this pricing strategy is pretty simple there are some drawbacks to it. The exclusive circumstances where this kind of pricing operates profit maximizing are described by average costs remaining fairly stable through time and at any point in the demand curve (e.g., Nagle and Holden 1995, Lilien and Kotler 1983, p.405-407). Unfortunately these conditions rarely happen. Cost-plus pricing also ignores information about consumer behavior and the competitive environment, which turns out to be another weakness.

However, there are also some advantages with cost-plus pricing. Since managers usually obtain relatively little information on the demand function, it is more likely that they tend to use cost-plus pricing (e.g., Wilkes and Harrison 1975). Another organizational factor that supports cost-plus pricing is risk aversion. Managers have to fulfill certain internal margin requirements. It turns out to be more secure to price adding a predefined markup. It is also important to note that managers usually have to decide about numerous prices simultaneously. To capture that complexity the most secure way of pricing will be cost-plus (Noble and Gruca 1999).

Regarding the maturity of the product one can differentiate posted prices in other different categories (e.g., Noble and Gruca 1999). The most important pricing strategies for this work are competitive pricing strategies where the product is already established in a market. In this area one can distinguish three strategies. First, leader pricing may be an option for firms. This strategy may prove successful for the market leader. This firm initiates price changes and expects others to follow. Since this firm obtains most of the market it also tends to display higher prices than its competitors which use the leader's prices to set their own prices (Noble and Gruca 1999). As already mentioned, it is common that the leader obtains the highest market share as well (Kotler 2006). The preconditions for such a market environment are easy detectable price changes (Nagle and Holden 1995), inelastic total demand (Guiltinan 1987), low costs (Nagle and Holden 1995), and high factor capacity utilization (Noble and Gruca 1999).

Second, a firm could conduct parity pricing. This means that a firm just copies the prevailing price or maintains a constant price level between its competitors. This strategy demonstrates weakness because the firm does not act on its unique power but rather reacts on the market's will (e.g., Noble and Gruca 1999). If a firm sells a superior product it should command price premiums. Usually consumers accept the markup due to superior features of the product and the firm should earn the rent for its better product. If the firm operates with cost advantages compared to its competitors, it should become a low-price supplier. The firm should hand over the cost savings to its consumers and therefore extend pressure on its competitors. Finally, the firm could afford that discount. Thus, the unique reason for firms to conduct parity pricing arises if the firm has to cope with high costs in a mature market (Guiltinan 1987). To sum up, the market conditions to command such a pricing strategy are composed of easily detectable price changes (Nagle and Holden 1995), inelastic total demand (Guiltinan 1987), high factor capacity utilization (Noble and Gruca 1999), low market share (Nagle and Holden 1995, Kotler 2006, p. 471-500), and low product differentiation (e.g., Noble and Gruca 1999).

The third pricing strategy is to become a low-price supplier. If the firm obtains some cost advantages they should be exploited and handed over to consumers (Nagle and Holden 1995). Consumers may regard these discounts and flock to the firm. A threat that could arise with that strategy is that if the firm exploits the lack of price knowledge in the market and undercuts its competitors, a damaging price war might result (Noble and Gruca 1999). All firms start to cut back prices and in the end the firm initializing that price war may be worse off than before because profits certainly drop since the price-cost spread scales down. This might be even worse, if a competitor obtains higher cost advantages and thus attracts additional consumers. The firm's market environment to perform that kind of pricing is composed of a low market share, high brand elasticity, and low product differentiation (e.g., Noble and Gruca 1999). Thus, an aggressive price policy should be commanded in such a dynamic environment.

For new products three alternative pricing options are available to firms. First, the firm can conduct a skimming strategy. This strategy commands an initial high price to target consumers who are insensitive to this high price because of special needs (Guiltinan 1987). The firm could take profit of its temporary monopoly position until competitors catch up. This strategy can usually be observed with new, highly technical gadgets, where innovators, i.e. those consumers who purchase that product first, are willing to pay a markup. Conditions which foster such a pricing strategy turn out to be high product differentiation, consumers with special needs and price insensitivity, major product enhancements, high factor capacity utilization, and a lack of cost advantages due to scale or learning (Guiltinan 1987, Noble and Gruca 1999).

Second, the opposite strategy, namely penetration pricing. With that strategy the firm initially executes low prices to speed up adoption or establish a de facto standard. This strategy proves to be successful at firms which experience cost advantages due to scale (Tellis 1986). A prominent example of successful penetration pricing is Apple's iPod. The major source of income stems not from sales of iPods but from sales of music titles. A more recent example is Sony's PS3 where estimates claim that Sony loses almost $ 250 per console (Goldstein 2008). The supporting conditions to perform penetration pricing consist of low product differentiation, minor product revisions, elastic demand, and low factor capacity utilization (Guiltinan 1987, Noble and Gruca 1999).

Third, the firm could command experience or learning curve pricing, which is very similar to penetration pricing. Again, the firm initially sets low prices. Later on, the firm takes advantage of the scale. Unit costs start to decrease as volume increases due to familiarity (Kotler 2006, p. 471-500). Thus, the goal is to build up a critical mass quickly and thereby drive down unit costs. The success of such a strategy is still ambiguous, since the effect of scale and learning could hardly be estimated a priori. However, the prevailing conditions are the same as for penetration pricing, except that the factor capacity utilization should be low (Noble and Gruca 1999).

Since the current work does not deal with dynamic pricing strategies, although they should certainly be named, a short overview of these strategies is given in the following. Price bundling may be useful for cross-selling purposes. The firm offers products in a bundle without integration. Consumer value pricing is given where firms like Wal-Mart and IKEA offer fairly low prices for products which nevertheless serve good quality. The current list is not meant to be exhaustive. For a complete review refer to relevant literature (e.g., Noble and Gruca 1999, Thaler 1985, Guiltinan 1987, Tellis 1986, Nagle and Holden 1995, Skiera 2000, Kotler 2006, p. 471-500). The most dynamic strategies are auction-type pricing. These strategies have become more and more important partly due to the spreading of the Internet. The power of these strategies foremost resides in pricing each individual consumer different and therefore make comparison impossible. Basic auction sites like eBay utilize for example English auctions to sell products to prospective consumers. Firms in some industries (e.g. airline industry) pursue yield management, i.e. they frequently change prices to match demand (Boyd and Bilegan 2003, Biyalogorsky et al. 1999). Due to lower menu costs, frequent price adjustments are also used to explore consumers' demand function (e.g., Baye and Morgan 2001, Wertenbroch and Skiera 2002). Evidence for frequent price changes is also found for computer components (Ball and Romer 1991). Further, frequent price changes make it difficult for consumers to estimate the true value of products (Oh and Lucas Jr. 2006). This strategy helps firms to avoid strong competition and maintain higher profits (Bakos 1997).

There are thousands of pricing strategies out there and finding the optimal one to apply may be difficult. In the current thesis we restrict the pricing strategies on posted prices and try to find optimal strategies within that restriction.

2.7 Task Definitions

Task definitions are referred to as situational conditions and their generated shopping strategies. Task definitions specify goals a consumer forms to resolve needs emerging from a specific situation (e.g., Marshall 1993). Another definition comes from Foxall (1994). He described task definitions as "... orientation, intent, role or frame of a person through which certain aspects of the environment may become relevant".

In an earlier study Belk (1975) used a revised stimulus-organism-response model and suggested five groups of situational characteristics which are responsible for triggering distinctive behaviors depending on a person (see Figure 2.2). These characteristics will be discussed in the remainder of this section. The impact of environmental situations on consumption habits is also explored in more recent studies (e.g., Kroeber-Riel and Weinberg 1999, Xie and Shugan 2001, Balasubramanian et al. 2005).

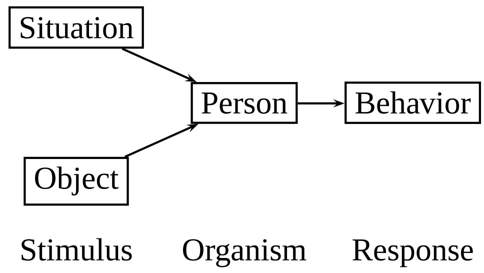

Figure 2.2: S-O-R Model (Belk 1975)

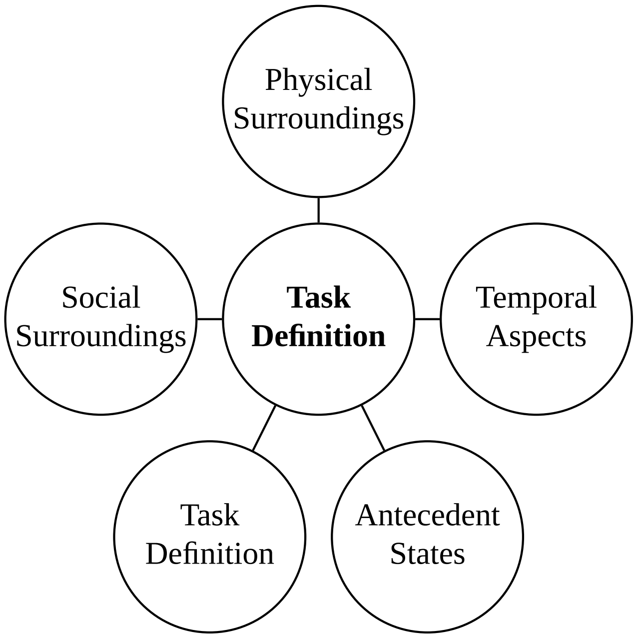

Figure 2.3: Parameters of Task Definitions

Figure 2.3 shows all parameters influencing a certain task definition for shopping. Each individual parameter will be described in the following sections.

2.7.1 Physical Surroundings

First, physical surroundings like geographical locations, the shopping environment with its lights, scents and sounds and even the weather, play a role (Belk 1975). The offline environment is especially feasible for exciting all five senses and inspires thoughts and feelings of human beings. This influence may change consumption patterns (e.g., Bitner 1992, Raghunathan and Irwin 2001). Impulse

buying, for example, more often happens in traditional stores since multisensory attributes are harder to resist (Shiv, Baba and Fedorikhin, Alexander 1999).
The online channel on the other hand is bound to specific restrictions concerning atmospheric experiences. These differences may help to differentiate the online channel from the offline channel (e.g., Alba et al. 1997, Eroglu et al. 2001, Menon and Kahn 2002).
Besides that, the Optimum Stimulation Theory may explain different needs of arousal. The optimum stimulation level (OLS) is a unique attribute for each individual consumer, which describes his response to any environmental stimulus (Raju 1980). When consumers are understimulated, or they generally demand increased stimulation, they tend to seek higher stimulation and vice versa (Menon and Kahn 2002). Thus, web site design must provide enough challenges to arouse consumers. But arousal should neither be too much nor too little, or consumers become frustrated and forego purchasing online (Novak et al. 2000).

2.7.2 Social Surroundings

Second, social surroundings determine also situational characteristics. The presence of friends or sales personnel may alter the purchase outcome (e.g., Bell 1967, Albaum 1967). In an early study on ethnicity, Stayman and Deshpande (1989) found different food consumption patterns depending an different social surroundings.
The store clientele, the social class appeal and the self-image congruency may impact channel choice (Lim and Dubinsky 2004). Raghunathan and Corfman (2006) put this statement in other words and assert that other persons shopping during a shopping trip may influence perceived utility. This utility might be higher the more similar the behavior of other consumers is perceived.
The quest for socialization seems to exert also tremendous effects on the purchase behavior. Consumers' desire to be part of social milieus or of stimulating environments may influence channel choice (Balasubramanian et al. 2005).
On the other hand the Internet allows for more anonymity. This feature is especially relevant when purchasing for example erotic articles. Avoiding embar-

rassment may also appear to be decisive in buying health-related products or for investors preferring online brokers (Konana and Balasubramanian 2005).

2.7.3 Temporal Aspects

Third, temporal aspects influence shopping behavior. On a broad view, time of day or season of the year may play a role. But also more specific parameters like time to payday or a simple time constraint influence shopping behavior (e.g., Mattson 1982). This aspect is closely related to time saving. Information search costs are assumed to be lowest in the online environment (e.g., Bakos 1997, Lynch and Ariely 2000). Thus, the Internet seems to provide advantages in time-pressure situations. But this advantage may be no longer relevant if for example consumers like shopping. In this case consumers calculate low opportunity costs for searching the offers (Marmorstein, Howard et al. 1992). Time pressure could change online versus offline shopping habits (van Kenhove et al. 1999).

It seems obvious that consumers are confronted with a trade-off between different purchase alternatives. On the one hand a consumer could buy the product online and wait for the delivery to save a certain amount of money. On the other hand the consumer could trade off this money for an instant purchase in the nearest traditional store (e.g., Keeney 1999, Chircu and Mahajan 2006). Hitt and Frei (2002) explained differences in online banking behavior with the opportunity cost of time. To highlight the complexity of this trade-off, Read and Loewenstein (1995) coined the word ”Positive Time Discounting”, which expresses consumers preference for immediate consumption.

In a different environment the temporal aspect may also be a crucial issue. Balasubramanian et al. (2005) suggested the economic goal for the channel choice to be strongly influenced by the consumers' availability of time.

But the online channel may also run into problems different from delivery. Web waiting times, poor navigation or loading times for example negatively affect consumers' evaluation of a web site, which may alter purchasing behavior in favor of traditional stores (Novak et al. 2000).

2.7.4 Task Definitions

Fourth, the task definition itself may change shopping behavior. The description of the shopping task may alter the purchasing behavior (Belk 1975). If a consumer intends to buy a gift for a friend or his children he would find himself in a different situation than purchasing an appliance for personal use. Thus, shopping for a present or shopping for oneself causes big differences regarding shopping habits (e.g., Gehrt et al. 1991, Mattson 1982, Hansen and Deutscher 1977). Mattson (1982) empirically analyzed shopping behavior on the task of gift buying. He found that consumers visit different stores for different tasks. A crucial shop characteristic for gift shopping is return policies. Since specialty stores usually have more stringent policies, consumers prefer department stores for gift shopping.

In a study on purchasing habits regarding do-it-yourself products van Kenhove et al. (1999) revealed that certain stores were visited more frequently than others for specific task definitions since each type of store carries its unique advantages. For urgent purchases, consumers value proximity, quick service and availability. Price, service, assortment and even quality turn out to be of minor interest. On the other hand, the store choice for regular purchases is determined by proximity, low prices and sufficient stock.

In the case of gift shopping Gehrt and Yan (2004) also found a significant relationship with traditional stores and not towards online shops. Further, they observed consumers' preference for traditional stores when purchasing experience goods to minimize risk.

A more comprehensive study by Balasubramanian et al. (2005) points out that symbolic meanings in gift giving drive consumers to spend more time at the purchasing process. This time spent increases consumers' utility and may increase a gift's meaning and value. Since traditional stores call for higher personal involvement consumers may prefer them over online stores for the task of gift shopping.

2.7.5 Antecedent States

Fifth, antecedent states may also alter current shopping behavior. Emotions seem to be central to consumers' actions. Current moods (e.g., anxiety, pleasantness) and conditions (e.g., cash, illness) may change the importance of a specific purchase (Belk 1975).

A conceptual model by Gardner (1985) highlights the mediating role of mood states. Mood states exhibit some influence on consumer behavior. Consumers in a bad mood may go out shopping to cheer themselves up, whereas consumers in a good mood may undertake only those shopping activities which support their positive mood, i.e. activities with some positive outcome.

Donovan et al. (1994) found that shoppers' emotional states may serve as good predictors for actual purchase behavior. Pleasure could project the extra time a consumer will spend in a store and also the extra money he will, although unintended, spend. Another important predictor was found to be arousal. Arousal could serve as a sound proxy for spending less in unpleasant environments.

Sweeney and Wyber (2002) show that music in a women's cloth store could impact purchasing behavior. Music and its characteristics both influence emotions. Highest levels of pleasure could be obtained by playing slow pop or fast classical music.

A discussion on the emotional power and its partitions can be found at Yani-de-Soriano and Foxall (2006). They argue that pleasure, arousal and dominance are all important determinants describing consumers' consumption habits.

Recently Fiore and Kim (2007) tried to form a conceptual model to explain consumers' shopping experience. Their model also includes these antecedent states. Furthermore, it is an enhancement of Belk's (1975) S-O-R model (see Section 2.7).

Chapter 3

Reservation Prices

The reference price or reservation price determines a price against which a purchase price is judged (Monroe 1973). Normative reference prices denote consumers' evaluation of fairness (Bolton and Lemon 1999, Campbell 1999, Kahneman et al. 1986). Fairness is an elusory concept. What consumers perceive as fair strongly depends on price knowledge from prior purchases and competitors' prices but also on consumers' assessment of firms' costs and profits (Bolton et al. 2003, Thaler 1985).

Thus, the reference price may be the "cornerstone of marketing strategies" (Jedidi and Zhang 2002). The knowledge of reservation prices could guide firms in implementing pricing strategies such as penetration pricing, skimming or other pricing strategies. In his seminal article, Simon (1955) already emphasized the impact of reservation prices. Further, various effects such as framing and different biases towards gains or losses were revealed (Kahneman and Tversky 1979).

Reservation prices seem to be a complex artifact. From the reservation price literature different frameworks on the formation of reservation prices exist. The memory-based approach argues that last paid prices influence the current reservation price (Kalyanaram and Little 1994). Consumers keep a history of past prices in mind to compute their current reservation price. This model lays strong cognitive requirements on consumers because they have to remember a history of prices. For each brand a separate price history might be necessary (Briesch et al. 1997).

The second framework relies only on current prices of alternative brands. This model puts less weight on the cognitive abilities of the consumers. Consumers just compare current prices of alternatives and form their individual reservation price out of that values (Hardie et al. 1993, Rajendran and Tellis 1994).

Others argue that reservation prices are also dependent on contextual factors. How often a brand is on sale, store characteristics and price trends may alter reservation price formation (e.g., Winer 1986). Reservation prices cause various effects. Reservation prices affect consumers' brand choice decision. Winer (1986) found a "sticker shock" effect which explains differences in reservation prices and purchase prices. He argues that a positive price difference increases consumers' utility. On the other hand the prospect theory (Kahneman and Tversky 1979) states an asymmetric reference price effect, i.e. if the observed price is higher than the reference price consumers perceive this negative price difference as loss. The loss is perceived higher than a comparable gain due to asymmetric perception.

Krishnamurthi et al. (1992) found significant relations between purchase quantities and consumers' reservation price. The effect is mediated by loyalty. Loyal consumers tend to be more sensitive to gains than to losses when shopping for their favorite brand. The time of a certain purchase has also been found to be affected by reference prices. On every purchase, consumers undertake some discounting to evaluate the attractiveness of an immediate purchase versus a postponed purchase (Bell and Bucklin 1999). Mazumdar et al. (2005) give an overview on effects exerted on brand choice, quantity and timing decisions caused by reservation prices.

Finally, Greenleaf (1995) shows that reference price effects could indeed increase profits. Thus, firms may be better off knowing the reference prices of their consumers.

Chapter 4

Research Scope

The e-commerce business model by Hansen (1998) and its extensions (Hansen et al. 2004) should serve to integrate the current research into a firm's decision scope.

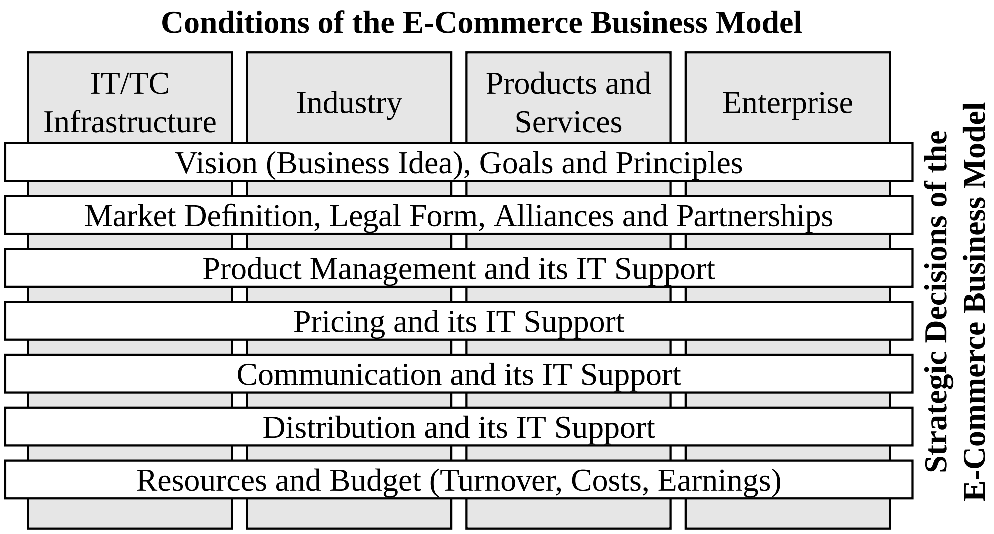

Figure 4.1: Elements of the E-Commerce Business Model (Hansen 1998)

Figure 4.1 displays the e-commerce business model. As one can see, this model distinguishes strategic decisions, which could be influenced by the firm itself, and conditions to reduce complexity. Conditions remain fixed and can not be altered in the medium term.

The first condition is related to the consumer-centric infrastructure of information and telecommunication technology. This condition refers, among other parameters, to the penetration of Internet access points, the access fees and Internet usage behavior. In short, this condition determines which prospective consumers could be addressed by an online shop. The industry condition describes the competitive environment as well as consumer behavior. One might see this condition as the market environment. On the one hand it refers to competitors, market development and legal issues, and on the other hand to consumers' buying patterns, their socio-demographic attributes and psychographic attitudes. The third condition is related to the nature of the product, i.e. physical attributes of the product. But this condition is also related to consumers' acceptance of buying such products online, e.g. consumers' willingness to order CDs (i.e. a standardized product) online is much higher than their willingness to purchase vegetables online, where sensory attributes dominate the purchase decision. The last condition is the firm itself. This condition is a result of financial power, market share, current IT-infrastructure, managerial skills etc.

Strategic decisions pertain managerial decisions which could be altered in the short term. The also contain the marketing-relevant decisions of pricing, product, promotion and distribution (Kotler 2006).

4.1 Discussion of Conditions

The current work addresses the problem of setting prices in a multichannel environment. A firm which operates a traditional store as well as an online shop should carefully manage both channels. A problem arises of consumers switching from one distribution channel to another. Thus, the first condition copes not only with consumers in online channels but also with consumers of the same products via the traditional channel. The typical firm this work examines maintains both distribution channels and is exposed to both kinds of consumers. Therefore, a reasonable strategy to manage both channels is inevitable for the firm.

The industry related condition is the most relevant part for the current work. As already noted in earlier articles, socio-demographic factors are an important determinant of consumers' buying behaviors (e.g., Yang et al. 2005, Madlberger 2006, Sheth 1977, Fox et al. 2004, Keaveney and Parthasarathy 2001, Li et al. 2007). Chapter 2.7 discusses those issues in broad. On the other hand relying on socio-demographic data alone often results in ambiguous outcomes (e.g., Hitt and Frei 2002). In the current work consumers are aggregated by distributions of reservation prices and switching probabilities. The reservation prices are depicted by two probability functions, one for each channel. Depending on the price in an individual channel, a certain fraction of consumers may undertake a purchase in that channel. The switching probabilities are also defined by probability functions which determine at which price differences a consumer may migrate to any cheaper alternative channel. So these probabilities describe the whole consumer market. Prices and price differences will alter the outcomes.

The nature of the products sold will differ. From the results of the survey, different behavioral patterns of consumers regarding specific products were extracted. Thus, this condition is closely related to the industry-related condition. Books, clothes and digital cameras were taken as exemplary products for doing business in the Internet. As we will see, the nature of products changes the way they are bought. Additionally, different pecuniary advantages are taken into account to lay weight on one of both channels. Therefore, consumers will flock to the channel which looks advantageous to them for purchasing a certain product. An example may serve to make things clear. Assume a firm offers equal prices in both channels. Though, from the nature of the product the online channel appears, because of its features like convenience or home delivery, cheaper. Thus, although both prices are equal the online channel attracts consumers from the offline channel because of the “cheaper feeling”. This pecuniary advantage could also be capitalized on in another way. Since the online channel contains a pecuniary advantage of a certain amount, a firm could mark up that amount at the online price and only at this price consumers become indifferent between both channels. So, consumers become indifferent between both sales channels although prices are different.

Characteristics of the firm itself are not of particular interest for this work. It is assumed that the firm is equipped with the necessary infrastructure to maintain both sales channels. These factors will be kept constant throughout the simulations.

4.2 Discussion of Strategic Decisions

In this dimension we foremost consider the pricing policy of a firm. But within a given budget constraint, specific other marketing policies, in particular actions out of promotion and distribution policy, which are under a retailer's control, are considered for any given product category. The product dimension is given exogenously. Thus, in the strategic dimension the firm of interest holds the chances to alter prices in both channels, and to spend a certain amount of money on the promotion and distribution dimension of each channel to foster sales. One note here should soften the mid term steadiness of the conditions. The firm could influence the shape of the switching probabilities at a certain amount through its marketing activities. Thus, if a firm conducts perfect marketing activities it could draw advantages from such behavior by generating higher profits. Thus, conditions of the industry are not that fixed. All other probabilities (e.g. reservation prices), pecuniary advantages of a certain channel and weights of marketing actions remain stable.
This work is affected by the following conditions:

Infrastructure of information and telecommunication technology In the simulation the number of online consumers relative to the number of offline consumers will be changed frequently, thus that condition impacts this work.

Industry This condition is the most important one. On the one hand the competitive landscape is changing through the work, i.e. the performance of the competitor will be modified. And on the other hand consumers' purchase behavior is also changed by the influence of firm's marketing actions. In this work this condition is much related to the initial state or the given market environment.

Nature of products and services Natures of products remain stable within a certain product. Since three products will be analyzed cross comparison could give deeper insights in the effects caused by different product classes.

Enterprise The internal firm structure also remains stable. This work does not touch the financial strength or a firm's IT infrastructure.

4.3 Market Model

The whole model looks like Figure 4.2. The firm sets prices for a certain product.

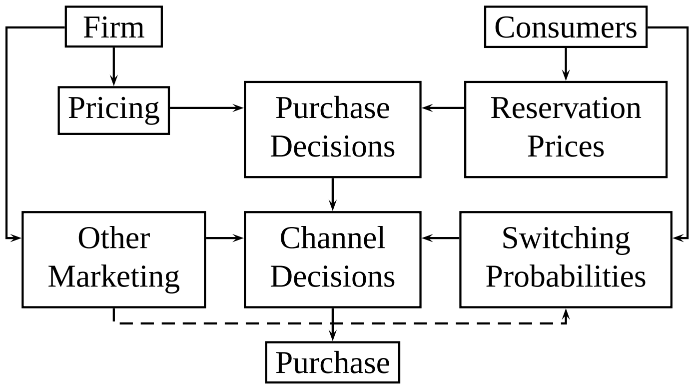

Figure 4.2: Market Model

In addition it performs a certain marketing program restricted by a given budget constraint. The marketing program could be in the field of promotion policy and distribution policy. Each policy affects consumers' purchase decisions in a different manner. This impact of a firm is highlighted by the dashed arrows in Figure 4.2. Note that the price determines the purchase of a certain product. The channel decision afterwards is influenced by the marketing activities. Consumers are described by their reservation prices and switching intentions. The reservation price is given and could not be influenced by the firm. The switching probability on the contrary could be affected by appropriate marketing actions. From the concurrence of a firm's pricing and consumers' reservation prices individual purchasing decisions emerge. A consumer having a reservation price above the current price will undertake the purchase, but those consumers exposing reservation prices below the current price will forgo the purchase. Since two sales channels are assumed in this work each consumer obtains two independent reservation prices, one for each channel. The price set by the firm determines if the consumers is actually interested in purchasing the product. The only issue which is not yet answered concerns the choice of an appropriate sales channel. If the consumer intends to undertake the purchase firms could influence the channel decision through their marketing activities. Finally, the purchase decisions is made and the consumer buy in the cheapest channel.

The scope of actions for firms is therefore limited to commanding prices and maintain marketing programs. The pricing itself only affects the reservation prices and ascertains the number of interested consumers. By commanding different prices in each channel consumers may migrate from on channel to the other. This migration could be hampered or fostered by appropriate marketing activities.

The final outcome, say profit, could then be evaluated and if necessary the firm may alter its pricing and marketing strategies. The new setting applies for the next cohort of consumers which start the purchasing process anew.

This process of finding appropriate prices is long and could be painful if false decisions occur. Therefore, the model should quicken the process of finding suitable prices by a simulation. The simulation should give the firm insights into its pricing decisions in an artificial environment. Thus, different marketing strategies could be applied without affecting real time business.

This market model should help marketers to test pricing strategies in a virtual environment without harming their market. Marketers should be able to alter prices and marketing strategies and receive some information on their impact on the market. The accuracy of the predictions is closely dependent on a reliable initialization of all relevant parameters. An exemplary initialization will be given in Chapter 8 and for each individual product.

Chapter 5

Conceptual Consumer Model

The distribution of reservation prices may ask for more profound grounding. Therefore, we suggest a conceptual model to describe the consumer market. This model is an assembly of various results from the current literature. It should highlight how different articles may fit together to draw one big picture. The model (see Figure 5.1) consists of six parts, namely demographics, product, shopping goal, latent demand, reservation prices and of course the firm itself. All parts will be explained in the following paragraphs. The basic idea is that demographics and the nature of the product determine a certain shopping goal associated with that purchase process. The shopping goal originates latent demands at the consumers. These demands include for example security, assessment and immediate usage. From this demand the reservation price of a consumer should be developed. Note

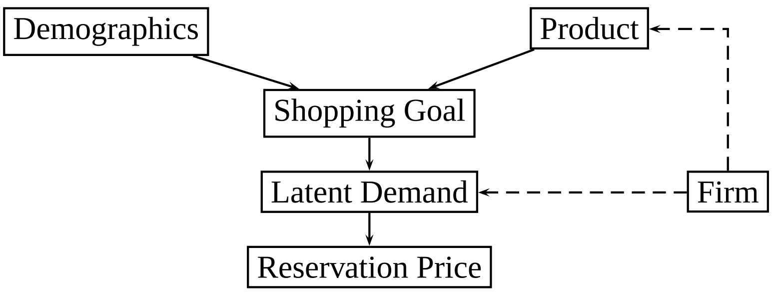

Figure 5.1: Conceptual Consumer Model

that the firm could influence the latent demand since it could invest for example in extending online security or faster delivery. Thus, the dashed arrows should indicate options of influence of a firm. A firm could alter the product but this option is beyond the scope of the current work.

This conceptual model (see Figure 5.1) is related to the stimulus-organism-response paradigm (S-O-R) (Hull 1951). Belk (1975) uses a modified S-O-R model (see Figure 2.2) to emphasize the impact of situational surroundings on behavior. The concept of the S-O-R paradigm applied to the proposed conceptual model could be regarded as an enhancement of the former.

In the remainder of this chapter we will give a detailed overview of relevant literature concerning each node of the conceptual model.

5.1 Demographics

It is a long known issue that demographics influence consumer behavior (e.g., Yang and Lester 2005, Li et al. 2007). A set of studies reveal different effects of demographic characteristics on the purchasing attitude. By the use of a conceptual model, Schoenbachler and Gordon (2002) single out demographic differences as a source for channel choice. They also note that lifestyle factors, the need for convenience or entertainment conjoined with demographic measures like age, gender, income, occupation, household size and education should be predictors of online shopping. A demographic difference was also found by Keaveney and Parthasarathy (2001) concerning online service switching. They argued that higher income and higher education is related to a consumer's propensity to continue a service. Analyzing shopping patterns across retail format, Fox et al. (2004) found that for example family size and working women in a household alter purchasing behavior. In an explicit survey Yang and Lester (2005) found clear differences in the online behavior of men and women. Women seem to be influenced by their attitude towards money and their computer anxiety. An amplifier for online purchases for both sexes was found to be hours spent online. Madlberger (2006) highlights an interesting spending difference between males and females regarding online shopping. Female consumers would spend more online the more favorable their attitude towards the online shop would be.

Gupta et al. (2004) reveal in their study on books, airline tickets, wine and stereo systems that consumers differ in their channel preferences. Burke et al. (1992) and Liang and Huang (1998) also describe different behavior of offline and online consumers. These findings are confirmed by other studies (e.g., Degeratu et al. 2000, Danaher et al. 2003). Others state that in the light of those results, the online channel helps to target different consumers with different services and thus exploit systematic differences to offline consumers (e.g., Steinfield et al. 2002, Shankar et al. 2003). Some firms even create a new brand for their online channel (e.g., Specht 2001), e.g. "Créateur de Beauté" as online brand of L' Oréal (see Hansen and Neumann 2005, p. 662). Different brands pay if the firm targets different consumers (e.g., Randall et al. 1998, Raju et al. 1995). Connolly (2004) even mentioned that each sales channel needs its specific brand.

From the literature one should conclude that demographics will tell something about purchase behavior. It might be the primary source of differences between online and offline consumers.

5.2 Product

Without question the product is a major determinant of the reservation prices. A refrigerator will, e.g. typically originate higher reservation prices than a CD. To master as many products as possible it is necessary to classify them. A well known differentiation comes from Kotler (2006, p. 410-412), who categorizes products in classes like convenience goods, which are bought frequently, immediately and with a minimum of effort, shopping goods, where consumers compare products on the basis of price, quality, style and utility, specialty goods, which are unique brands, and unsought goods which consumers are not aware of buying and do not know exactly.

But it is easy to guess that consumers' inherent classes may differ from these suggestions, especially when the shopping process comes into play. When talking about consumers' purchasing behavior, researchers developed an alternative distinction to take care of differences of diverse sales channels. For example, one can not push high prices if consumers do not care about brands and undertake price comparisons before purchasing the product, especially if they buy online.

Thus, marketers long for a classification which may help them to incorporate such differences when deciding about prices.

In his ground-breaking paper Stigler (1961) was the first who mentioned that search may decrease costs and Nelson (1970) utilized that result and categorized products into experience and search goods. This basic distinction highlights diverse consumer behavior when purchasing products through different sales channels. The online channel seems perfectly practical for searching. Thus, marketers have to be more sensitive to how consumers class products regarding their purchase behavior. Therefore, products have been categorized into commodity, “quasi”-commodity and look and feel products (e.g., de Figueiredo 2000). Empirical studies take other discrimination parameters like search, experience-1, experience-2 and credence (e.g., Girard et al. 2003), or complex, intelligent, simple and light (e.g., Choi et al. 2006).

All these classifications show the influence of the product category on consumers' purchasing process. Search goods are assumed to be described to all extent by technical notes and measures. Such an exhaustive textual description makes these items easy to compare and also easy to sell through the Internet, since consumers do not need to touch, feel or smell the product to become fully informed about the product attributes. This is the advantage of digital characteristics. The opposite would be experience goods, which could hardly be described by textual notes alone. Consumers sense risks if they were not allowed to feel, touch or smell such products. Thus, usually this kind of product turn out to be not very suitable for online selling since consumers tend to purchase through the offline channel for security reasons.

Chun and Kim (2005) give a good summary of these issues. They argue that some products exhibiting high consumer costs, e.g. perfumes and clothes, tend to display higher prices in the offline store because consumers are able to assess the quality a priori offline. Thus, consumers feel exposed to uncertainty from tangibility, smelling and seeing when purchasing online and want to be compensated for risk taking in pecuniary terms. For the same reason products with lower consumer costs tend to display higher prices in the online channel. These products do not need to be examined with the same effort as clothes and perfumes.

Therefore, product characteristics are indeed an important source of differences in the distribution of the reservation prices. But product characteristics show also to exhibit relevant impact on pricing strategies of different sales channels.

5.3 Shopping Goal

Mentioning shopping goals long ago entered marketing science. Although not referred to directly, shopping goals are very similar to task definitions which have been long known. Some early work on situational factors influencing consumer choice has been done by Ward and Robertson (1973) and Engel et al. (1969).

In a comparison of department stores and grocery stores Hansen and Deutscher (1977) noted differences regarding shopping preferences. If consumers enjoy shopping they may value high value for money, courteous sales personnel and advertising. On the opposite, if consumers dislike shopping they appreciate a fast check out, proximity and after-sales service. These differences may explain store choice.

A similar study by Mattson (1982) analyzed store choice on various occasions. His results show department stores to be more likely to be visited in gift shopping situations. Immediate sales personnel attention and a broad product selection determine the store choice at time-pressure situations.

Van Kenhove et al. (1999) undertook a similar study and revealed varieties of the store choice on do-it-yourself products depending on the surrounding situation.

A first work including the online channel into the store choice was Gehrt and Yan (2004). They reviewed situational factors influencing the choice of the retail format. A significant relation between gift shopping and purchasing experience goods at traditional stores was revealed.

Different tasks or shopping goals emerge in varied shopping behavior. Consumers form their task definitions or shopping goals to resolve the shopping process in a specific situation (e.g., Balasubramanian et al. 2005, Gehrt and Yan 2004, van Kenhove et al. 1999, Marshall 1993).

As Balasubramanian et al. (2005) point out, shopping goals have a tremendous effect on the channel choice. They suggest five distinctive factors which influence consumers' channel choices. These factors are economic goal, quest for self-affirmation, quest for symbolic meaning, quest for social interaction and reliance on schemas. In the remainder of this section we will discuss these five factors or goals.

First is the economic shopping goal. Consumers of this kind seek to minimize costs. This consumer aspires to maximize net utility, i.e. utility derived from the product less total cost of obtaining it. The first stage of the shopping process, information retrieval, is typically done online since search costs are cheapest online. The channel choice for the purchase itself afterwards depends on the product category. This first goal follows a stream of arguments dealing with minimizing transaction costs (e.g., Balasubramanian 1998, Bakos 1997, Liang and Huang 1998). Interestingly, Chircu and Mahajan (2006) noted that important factors influencing transaction costs are channel characteristics, consumer characteristics, product characteristics and shopping occasion.

Second, consumers strive for self-affirmation as the most important shopping goal (e.g., Steele 1988, Steele et al. 1993). Consumers, like every person, strive for positive self-regard which can be achieved by drawing on successful actions (Correll 1992). Thus, consumers like to prove their special knowledge on various product attributes. They want to feel, touch and see the products the buy. These consumers may behave ambiguously. For example, for clothes and groceries they tend to use offline stores to affirm their sensory knowledge, but for technical items like digital cameras or mp3 players the online shop may also be an acceptable alternative since all necessary information should be provided online.

Third, consumers express symbolic meanings with the purchase. This is mostly the case when buying presents or toys for children. Consumers purchasing such product categories for this specific shopping goal are typically very involved in the purchasing process, because the effort of the process itself also adds some symbolic meaning. For a present for their children such consumers spend time wandering across different stores and glancing at thousands of items to find the best gift for their children. Since the time spent for shopping is an important determinant expressing shopping effort, these consumers may prefer traditional stores.

Fourth, consumers have a need for experience and social influence. After a hard day working, these consumers like to reward themselves. They relax during the shopping trip and enjoy the experience. This kind of consumer obviously takes the offline store. They long for this experience, and not to forget, the reward has to be immediate. Another thing also important for this group is to chat with the sales personal. This behavior is reflected in the need for socialization. Since the online channel cannot provide this experience, these consumers also prefer the traditional sales channel.

Fifth, consumers which do not think about their shopping behavior. On their shopping trip they follow long acquired schemas or scripts. For their shopping trip they use the least possible cognitive effort. They behave as they have always behaved. These consumers change their behavior very reluctantly. Such a behavior may express some kind of security seeking.

Shopping goals are determined by the product and by the consumer himself. The variety of shopping goals seems to be a large source of the variance in the choice of the sales channel. Without knowing consumers' goals for different purchasing occasions, managers may find little potential to influence buyers' choice.

5.4 Latent Demand

This part deals with consumers balancing different "soft" aspects of the sales channels against each other. This includes issues like security, usability, delivery time, need for personal interaction and need to feel, touch and smell. The impact of these parameters is well documented (e.g., Li et al. 2007, Flavián et al. 2006a, Lim and Dubinsky 2004, Park and Kim 2006, Rotem-Mindali and Salomon 2007, Verhoef et al. 2007). Lim and Dubinsky (2004) explored relevant attributes for physical retail stores and online stores. They found the attitude toward online shopping positively related to a web site's merchandise variety and product information, as well as trust-building functionalities. An eye should be kept on delivery time since consumers' preference for immediate consumption is well known by the negative time discount utility. This form of utility addresses the trade-off consumers are confronted with on deciding about an immediate consumption or the chance of a lower price (Keeney 1999, Read and Loewenstein 1995). Hitt and Frei (2002) observed differences in the behavior of online and offline banking consumers and attributed these differences to opportunity costs of time and trust. Others noted that time pressure may alter shopping behavior, i.e. under conditions of time shortage consumers tend to rely on traditional stores rather than online shops (e.g., Gehrt and Yan 2004, van Kenhove et al. 1999).

Interactivity seems to be not of primary interest to online consumers (e.g., Lim and Dubinsky 2004). On the other hand interactivity could potentially enhance satisfaction, which in turn causes a positive influence on purchase behavior (e.g., Wang and Head 2007). Novak et al. (2000) noted that flow, which denotes the cognitive state sensed during online navigation, may be improved by enriched interactivity. Improved control increases convenience and results in higher satisfaction. A related term, namely enjoyment during shopping, turns out to be capable of lowering the subjective value of price-comparison shopping (e.g., van Birgelen et al. 2006, Marmorstein, Howard et al. 1992). Usability also appears to be a big issue, especially in online retailing (e.g., Flavián et al. 2006a, Clemons et al. 2002). Web waiting times, for example, affect shopping behavior negatively (e.g., Novak et al. 2000). On the other hand usability, as usually described for online purchases, does not play a role for purchases in traditional stores. However, Lumpkin et al. (1985) mentioned the weight of the ease of finding items in traditional stores, which may be treated as comparable parameters to online stores' usability.

Another important factor may be trust (e.g., Wang and Head 2007). Flavián et al. (2006b) showed the importance of trust for decisions in risky situations. Trust could also be used to command price premiums (e.g., Ba and Pavlou 2002). Surprisingly Mitchell and Harris (2005) show that trust is also an important aspect determining purchasing behavior in traditional stores.

Information displayed may also influence purchase decisions. The more information is displayed, the more beneficial it will be for firms because consumers' purchase decisions will be altered positively (e.g., Shankar et al. 2003, Park and Kim 2006). For traditional stores this item may be also related to service quality, especially pre-purchase service from sales personnel. The positive impact of these pre-purchase activities is well known (e.g., van Kenhove et al. 1999, Lumpkin et al. 1985).

The Internet is supposed to exhibit advantages in being more convenient than traditional stores (e.g., Litan and Rivlin 2001). Although holding different characteristics, convenience plays an important role in traditional stores as well as online stores (e.g., Lim and Dubinsky 2004, Lumpkin et al. 1985).

The breadth of product offerings is also known for being beneficial (e.g., Chen and Hitt 2002). Hansen and Deutscher (1977) on groceries, and van Kenhove et al. (1999) on do-it-yourself products mentioned different preferences in offline shopping depending on the shopping task. For getting ideas or doing difficult jobs a huge assortment is crucial, for urgent purchases just availability is relevant.

Nonetheless some consumers prefer traditional stores to see, feel and touch the products (e.g., Pan et al. 2002b, Alba et al. 1997). Consumers who strongly rely on such impressions will value them more and also demand them. If these effects are not apparent, they are likely to expect pecuniary compensations.

Security is a crucial parameter in purchasing online (e.g., Wang and Head 2007, Lim and Dubinsky 2004). But Park and Kim (2006) noted that security perception may be less important than other attributes, foremost information about quality. In traditional stores security may be of less relevance. By providing security enhancements a firms might draw consumers from insecure web appearances.

These items may be demanded with different strengths for each individual purchase occasion and for each separate sales channel. The shopping goal determines these attributes but a firm could influence these attributes by investing for example in security, education of its sales personnel or usability.

5.5 Formation of Reservation Prices

The reference price is a subjective value against which the purchase price will be judged (e.g., Simon 1955, Monroe 1973). It is a well known part of the marketing literature which influences consumers' choice and has its origins in different fields of psychology. One rationale for reference prices is found in Helson's Adaption-Level Theory (e.g., Helson 1964, 1973). This theory assumes that each stimulus is evaluated depending on specific internal rules. These rules represent joint effects of current and past stimulations. Thus, each consumer's valuation is based relative to his individual, inherent adaption level.

Another rationale for the concept of reservation prices stems from the Assimilation-Contrast Theory (Sherif et al. 1958). These authors presume a psychological price range which each individual consumer obtains. A price within that range will be perceived as acceptable. If the price lies outside the range it just will be noticed.

Kahneman and Tversky (1979) utilize these models in their Prospect Theory. Their theory suggests, based on a certain reservation price belonging to a specific consumer, different value functions for gains and losses. The shape of the value functions is assumed to be concave for gains and convex for losses. This asymmetry determines a typical behavior. Consumers regard losses more than gains. Putler (1992) found that consumers respond to a price increase above their reference price 2.5 times more strongly than to a corresponding price decrease.

Further empirical evidence for reservation prices and their effect on consumer choice comes from Kalyanaram, Gurumurthy and Winer (1995). They revealed the fact that permanent price promotions reduce reference prices. Two problems arise. First, subsequent promotions will no longer be regarded as such a bargain as earlier ones, and secondly, a price rise to “normal” prices will be accounted as a price increase. For a more complete overview on reference price research refer to the current literature (e.g., Mazumdar et al. 2005).

Also managers consider the lore of reservation prices as an inevitable ingredient in pricing (Anderson et al. 1993). Jedidi and Zhang (2002) discussed the importance of reference prices for deciding about different pricing strategies. The value-added by knowing about consumers’ reservation prices may be undoubtedly enormous.

The last part of the conceptual model could be seen as the integrative part of the whole model. Here all issues come together and result in an appropriate reference price unique for each individual. The shopping goal determines the latent demand for each channel. Thereafter, the latent demand defines markups or discounts depending on how a firm fits a consumer’s latent demand. This finally adds to the basic reservation price and results in an individual reservation price for each sales channel.

5.6 The Product-Shopping Goal Link

Form the literature about task definitions we know that situations influence purchase decisions. In an early study the impact of other persons shopping in the store and interpersonal interactions with sales personnel during the shopping trip may alter shopping behaviors (e.g., Bell 1967, Albaum 1967). Belk (1975) identified five different situational characteristics which trigger distinctive shopping behaviors. Investigations on task definitions, i.e. present purchases, emergency purchases, and similar situations revealed different shopping habits (e.g., van Kenhove et al. 1999, Gehrt et al. 1991, Mattson 1982, Hansen and Deutscher 1977). Even Internet usage plays a role for generating task definitions (Gehrt and Yan 2004). Online shoppers are assumed to be more adventurous, willing to try a retailer with an unfamiliar face and less sensitive to retailer atmosphere. Balasubramanian et al. (2005) argued that goals and relevance of specific channel characteristics may differ according to product or service category and consumers' experience, knowledge and preferences of information presentation. The causal link seems to be clear. Depending on the situational surrounding shopping habits of consumers change.

The question arises if some products are most of the time bought under the same situational surrounding, or to frame it in better words, if the product class defines the purchase behavior for the majority of purchase decisions. Take for example the purchase of a book. Consumers usually buy books in a certain manner. This purchase behavior may be stable, irrespective of the surrounding environment. On the other hand if someone is ill and needs some medicaments urgently, this situation is clearly an emergency case. Time is a crucial factor in such a situation. This poor human will not even think of purchasing the necessary medicine online. Compare that with the purchase of a book. If a consumer always facilitates the Internet to purchase books, there may be very rare occasions when a book is needed that urgently as to make him run to the next traditional book store. We assume that consumers tend to rely on known habits for purchasing different products, and changes may happen rather seldom.

In the current work the typical purchase of a product is given by a reservation price for each sales channel. This reservation price should therefore include the pecuniary advantage of a sales channel and further all shopping influences of a typical purchase. Thus, we are confident that the reservation prices are good enough to describe the shopping behavior of consumers. From the monetary difference between the channels switching probabilities could be estimated. Together with the reservation prices we assume to describe the whole consumer market satisfactorily.

Chapter 6

Basic Model

In this chapter the basic model will be derived. Step by step all components of the theoretical model will be explained and assembled. From the basic model first results will be deduced. Calculations regarding cannibalization effects, expected values and price elasticities will be presented to give an impression of the working of the model. This model will serve as the foundation for the simulations.

This model is an extension of a simulation model in a monopolistic environment (Gruber 2006). It provides the basis for the current model. The basic model consists of a monopolist undertaking business in a multichannel environment. The monopolist maintains two sales channels, an offline and an online channel. Consumers are described by a reservation price for each channel and allowed to migrate from the offline channel towards the online channel. The switching probability and the number of consumers available in each channel is given exogenously. The model identified optimal pricing strategies given certain exogenous parameters. The extensions of the current model are manifold. Consumers should be allowed to switch from the online channel of a firm to the offline channel of the same firm and vice versa. Further, consumers should be able to switch from one firm to the other one. Another extension should be the firms' option to spend money on marketing activities. These investments may alter consumers' attitude towards a firm. Thus, firms could obtain competitive advantages by conducting appropriate marketing activities.

We will focus on a duopolistic market environment, i.e. two vertically integrated firms with a direct distribution channel as well as a traditional store each. The firms distribute their product through both channels. Both firms offer the same product, thus product differences are not relevant for the channel choice of consumers.

For each firm we assume two different autonomous sales channels with a fixed independent maximum number of reachable consumers in each channel for both firms.

The rationale for such a distinction stems from the literature. Findings confirm that consumers behavior differs whether they purchase offline or online. Thus, consumers could be separated by their channel preferences (Burke et al. 1992, Liang and Huang 1998, Degeratu et al. 2000, Danaher et al. 2003). Further, existent literature argues that different consumers could be attracted by the online channel. These consumers demand diverse services and therefore firms could exploit these systematic differences versus offline consumers (e.g., Steinfield et al. 2002, Shankar et al. 2003). Another argument for describing the sales channels independently is because the prices in each channel could be set arbitrarily, especially if firms create new brands for their online appearance (e.g., Specht 2001, Connolly 2004), e.g. Créateur de Beauté as online brand of L' Oréal (see Hansen and Neumann 2005, p. 662). Hence a firm could set its prices in each sales channel independently.

To make the problem statistically comprehensible we limit the number of reachable consumers in each channel. Further, with a price of zero the firm will not attract all outstanding demand of the whole economy (e.g., Brynjolfsson and Smith 2000, Bakos 2001, Smith and Brynjolfsson 2001), i.e. some consumers stick to their channel choice even if the price for the same product in the other channel is zero. As reality suggests, we reject the assumption of fully rational consumers (e.g., Kahneman and Tversky 1979, Simon 1955). Indeed consumers exhibit some kind of inertia or state dependence, which makes them stick to their current choice (e.g., Seetharaman et al. 1999, Guadagni and Little 1983, Klemperer 1995). Finally we assume that every individual consumer just purchases one unit of the product.

Each firm quotes prices for the product in its sales channels. Let p_B and p_O be the price in the offline channel and the online channel, respectively. Assume that all prices in the whole economy are normalized and in between zero and one, where one is the highest price for the product across both sales channels and zero is a price of zero, that is to say $p_B, p_O \in \{0,1\}$. Since the model describes a duopoly, two firms act in the market. Thus, we denote the prices of firm 1 by p_{B_1} and p_{O_1}, and the prices quoted by firm 2 by p_{B_2} and p_{O_2}.

6.1 Reservation Prices

Assume that each consumer holds his own reservation price, which determines whether he buys or not. If the current price quoted in a specific sales channel is below or at least as high as the consumer's reservation price, the consumer will undertake the purchase. Otherwise, if the quoted price in that channel is above the consumer's reservation price, he will forgo the purchase. Assume that consumers in each channel are autonomous and therefore hold an independent reservation price. Thus, each firm has to deal with two different distributions of reservation prices. One distribution represents the behavior of potential offline consumers, the other one describes potential online consumers. Having these distributions one could observe the potential of a certain market related to various prices. If a firm is aware of its consumers' reservation prices it could utilize this information by setting prices optimal to maximize profits or sales. Since the model depicts a duopoly, both reservation prices affect both firms since each firm acts on the same consumer base. The market of offline and online consumers is shared among each firm's offline and online sales channel, respectively.
The probability of a consumer to have a reservation price above a quoted price $p_.$[1], i.e. the probability of a consumer to undertake a purchase through a certain

[1] The dot in e.g. $p_.$ is a placeholder for either B to determine the price as offline price, or O which assigns the price as online price. This naming convention is valid from now on if every variable in the formula has the same subscript.

sales channel at a particular price $p_{.}$, letting $f_{.}$ denote the according probability density function, is

$$1-\int_{0}^{p_{.}} f_{.}(x)\,\mathrm{d}x \tag{6.1}$$

In Equation 6.1 $f_{.}$ represents the probability density function of consumers' reservations price for a particular sales channel.

The shape of the distribution should describe consumers. For example one could expect the density function of the reservation prices to be more skewed to the left, i.e. to lower prices, in the online channel, since consumers expect lower prices in that specific channel (e.g., Ansari et al. 2005, Lee and Gosain 2002).

Let the number of maximum available consumers obtainable through the offline channel be $\widehat{b_B}$ and those obtainable via the online channel be $\widehat{b_O}$. Hence the number $b_{.}$ of offline or online consumers who definitely intend to buy at a certain price $p_{.}$ through a particular channel should be defined by

$$b_{.}=\widehat{b_{.}}\left(1-\int_{0}^{p_{.}} f_{.}(x)\,\mathrm{d}x\right) \tag{6.2}$$

As already mentioned, $f_{.}$ in Equation 6.2 represents the probability density function of consumers' reservation prices for any particular sales channel. To make further equations more readable we will utilize the corresponding cumulative probability function $R(p_{.})$ from now on, i.e. Equation 6.3 becomes the following

$$b_{.}=\widehat{b_{.}}\left(1-R_{.}(p_{.})\right) \tag{6.3}$$

From Equation 6.3 we infer that b_B could be interpreted as the basic demand function for the offline channel, and b_O as the demand function for the online channel. In the remainder of the work we will use the basic demand function synonymously with distribution of the reservation prices. Above all, it seems natural that for any firm there arises an incentive to open up a new online channel to cover additional consumers, which may increase the firm's total profit.

Since there are two firms competing in the market environment the basic demand function should be different if the prices of both firms differ. If, say, firm 1 offers a price higher than firm 2 in the offline channel the basic demand function for each firm becomes the following

$$b_{B_1} = \frac{\widehat{b_B}\,(1 - R_B(p_{B_1}))}{2} \tag{6.4}$$

$$\begin{aligned} b_{B_2} &= \frac{\widehat{b_B}\,(1 - R_B(p_{B_1}))}{2} + \\ &+ \left(\widehat{b_B}\,(1 - R_B(p_{B_2})) - \widehat{b_B}\,(1 - R_B(p_{B_1}))\right) \end{aligned} \tag{6.5}$$

Equation 6.4 gives the number of consumers with a reservation price above firm 1's price p_{B_1}. Those consumers are shared between both firms equally, i.e. each firm reaches half of those consumers exhibiting a reservation price above p_{B_1}. Firm 2, the one with the lower price p_{B_2} obtains also the same number of consumers as firm 1 determined by the price p_{B_1} (the number of shared consumers). Additionally firm 2 earns extra consumers by its lower price (see Equation 6.5). This extra rent is composed of consumers having reservation prices below p_{B_1} indeed, but above p_{B_2}, i.e. these consumers reject firm 1's price since it appears too high, but firm 2's price is lower than their reservation price and therefore acceptable.

From Figure 6.1 one could see that firm 1, which quotes the higher price, could obtain only consumers holding reservation prices above p_{B_1}. The number of consumers is represented by the shaded area indicated by $b_{B_{SHARED}}$. The problem is that firm 2 which quotes a lower price p_{B_2} also attracts consumers from this area. That is the reason for naming that area $b_{B_{SHARED}}$, because this number of consumers is shared between both firms equally.

Firm 2 could earn some extra consumers due to its lower price. The additional consumer base which is not shared with the competitor is labeled by $b_{B_{SINGLE}}$. This area specifies all consumers attracted only by firm 2's price, i.e. those consumers exhibiting lower reservation prices than p_{B_1} but higher reservation prices than p_{B_2}.

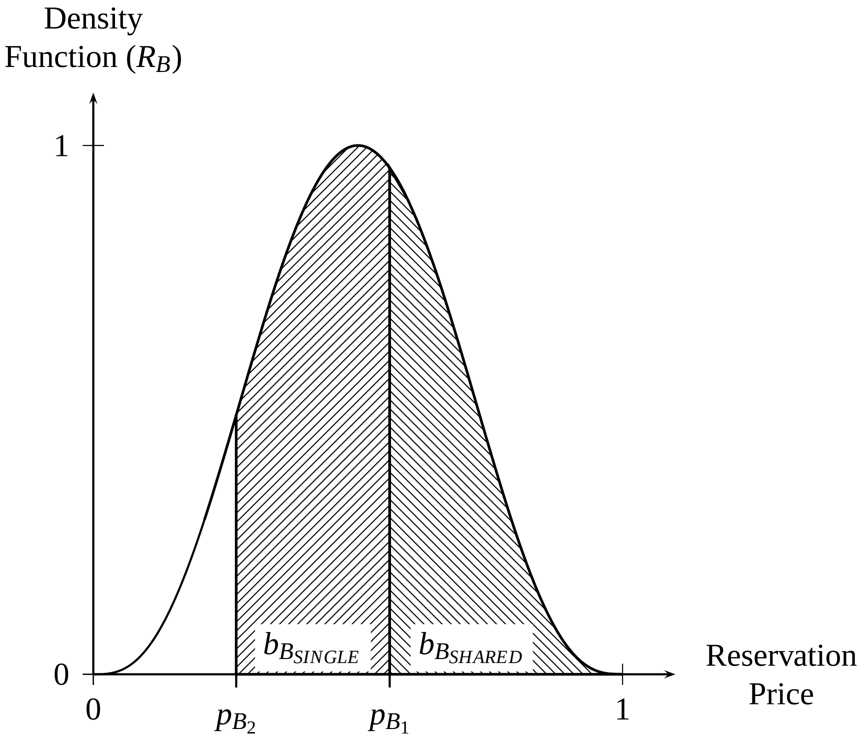

Figure 6.1: Probability Density Function of Offline Reservation Prices

Thus, the basic consumer base for a certain firm, denoting the competitor's price by p_{B_C} and p_{O_C}, respectively, will be

$$b_B = \begin{cases} \widehat{b_B}\,(1 - R_B(p_B)) & \forall p_B > p_{B_C} \\ \widehat{b_B}\,(1 - R_B(p_{B_C})) + & \\ \qquad + \left[\widehat{b_B}\,(1 - R_B(p_B)) - \widehat{b_B}\,(1 - R_B(p_{B_C}))\right] & \forall p_B < p_{B_C} \end{cases} \tag{6.6}$$

The basic consumer base resulting for the online channel is given by a similar equation. Note the different probability function for the distribution of the online reservation prices R_O.

$$b_O = \begin{cases} \widehat{b_O}\,(1 - R_O(p_O)) & \forall p_O > p_{O_C} \\ \widehat{b_O}\,(1 - R_O(p_{O_C})) + & \\ \qquad + \left[\widehat{b_O}\,(1 - R_O(p_O)) - \widehat{b_O}\,(1 - R_O(p_{O_C}))\right] & \forall p_O < p_{O_C} \end{cases} \tag{6.7}$$

Equations 6.6 and 6.7 both form the basic or initial consumer base for each sales channel. On these bases intra- and inter-firm switching occurs, i.e. consumers start to migrate towards alternative channels.

6.2 Intra-Firm Switching

If the online channel is available, consumers from the traditional entrenched channel may migrate to the online channel of the same firm and vice versa under the premises of this model. We assume that only those offline consumers switch channel which hold a reservation price above the current offline price and thus are in principle willing to buy offline. This assumption claims that the purchase intention happens first and afterwards the channel choice (van Baal and Hudetz 1999, p. 73). The switching affinity is determined by the price difference between both sales channels of one firm and the shape of the switching probability pertaining to each channel.

The switching probability is given by a stochastic measure. At low price differences few consumers switch to the lower price channel. With increasing differences more and more consumers may be likely to migrate to the lower priced channel. Thus, this probability should be more accurately referred to as not-accepted price difference, because the probability measure gives the likelihood of not accepting the current price difference and therefore switching the channel (see Figure 6.2). The probability of a consumer staying in the current channel and therefore accepting the price difference is given by the corresponding counter probability.

We use a stochastic switching probability because it seems plausible that this parameter is not measurable easily. Further, we endogenize the switching probability. The switching probability is assumed to be different for each firm. Thus, each individual firm has to manage two different intra-firm switching probabilities, namely the switching probability from the offline channel to the online channel of the firm itself S_{IBO}, and the switching probability from the online channel to the offline channel S_{IOB}. Here again S_{IBO} and S_{IBO} denote cumulative probability functions.

An example may clarify the situation. If we assume high search costs one could expect offline reservation prices to show a positive kurtosis, i.e. being flatter and the online reservation prices to be “relatively” more skewed to the left, i.e. concentrated around lower prices compared to the offline reservation prices. High search costs prohibit searching for the lowest price. Hence consumers may tend to purchase where they are. In the offline sales channel the probability function of the reservation prices may converge towards an uniform distribution, or be exactly uniform if a consumer has to take the first offer, or leave it (Stigler 1961). In such a situation consumers could not learn from additional price quotes in the offline channel since search costs prohibit searching. Since, by definition, obtaining information is cheaper in the online channel, it seems to be evident that the density function of the reservation prices of online consumers should be more skewed to the left compared to the density function of offline consumers (Bakos 1997, Lal and Sarvary 1999). But the flat shape of that density functions implies low switching probabilities, which we would expect in case of high search costs. From that it appears that any combination of the distribution of reservation prices in both channels would implicitly result in the corresponding switching probability for a given product in the current market.

As revealed in Figure 6.2 we assume that the amount of switching is determined by the difference between the online and the offline price. The *STAYER*-denoted fraction of consumers accepts the prevailing price difference and stays in the current sales channel. The other consumers denoted by *SWITCHER* do not accept that price difference and migrate from the online channel towards the firm’s offline channel. Thus, this distribution represents markups consumers accept before switching to the alternative channel. If $p_B \geq p_O$, then there occurs no migration from the online channel towards the offline channel. The probability function is assumed to result in $S_{IOB} = 0 \quad \forall p_O - p_B \leq 0$, i.e. if the online channel offers a price lower than the offline channel no consumer should hold an intention to migrate towards the offline channel. Otherwise, if the difference is one, all online consumers switch to the offline channel.

As already mentioned, each firm distinguishes two different not-accepted price difference probabilities. One cumulative probability measure describes the consumers who are not satisfied with the current offline price and thus migrate to the

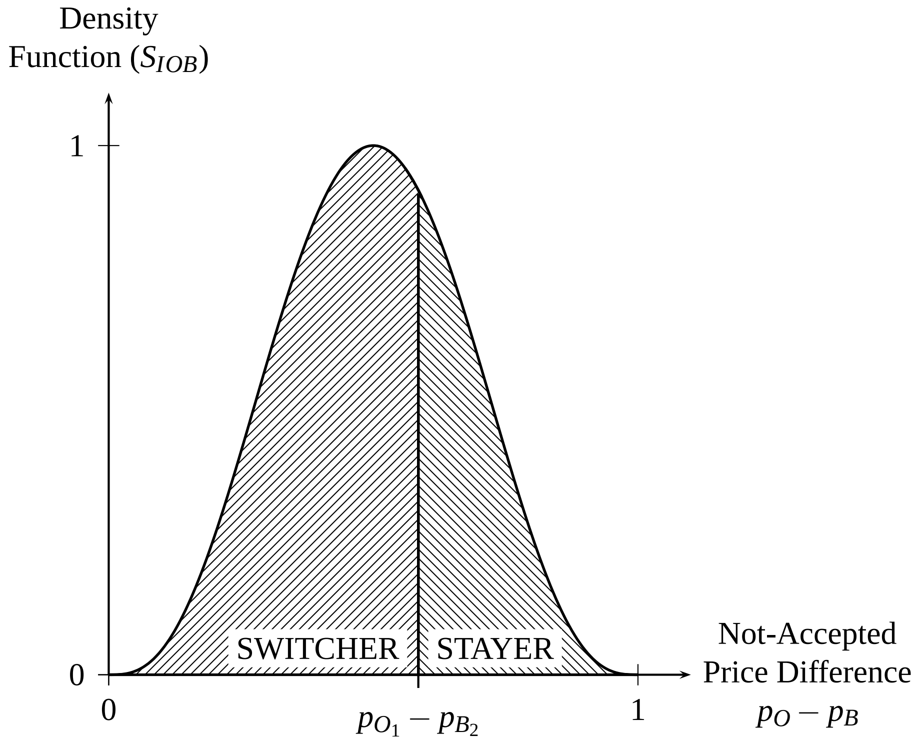

Figure 6.2: Probability Density Function of the Switching Probability from the Online Channel to the Offline Channel

online channel S_{IBO}, and the other one depicts online consumers switching from the online channel to the offline channel due to pricing reasons S_{IOB}. Since every firm manages its individual intra-firm switching probabilities, each has the corresponding firm specific subscript 1 or 2 attached. Thus, we get the fraction of consumers not migrating from the offline channel to the online channel, i.e. those who stay in the offline channel, for a certain firm by

$$b'_B = b_B\,(1 - S_{IBO}(p_B - p_O)) \tag{6.8}$$

Sometimes a certain channel holds some inherent price advantage, i.e. although both prices are equal, consumers switch to this specific channel. Consumers perceive some advantages from that channel and therefore demand pecuniary compensation in the alternative channel. Thus, an offset parameter $OF_{IBO} \in [0,1]$ is introduced to take account of that option. Equation 6.8 therefore becomes

$$b'_B = b_B \left(1 - S_{IBO}(p_B - p_O + OF_{IBO})\right) \tag{6.9}$$

The offset OF_{IBO} in Equation 6.9 assigns more power to the online channel. The higher this offset becomes the higher the price advantage of the online channel. If both channels display the same prices but the parameter OF_{IBO} is positive, then some consumers switch to the online channel nevertheless. Thus, this parameter is used to relay some competitive advantage on a certain channel. The numbers of consumers in the offline and in the online channel for a certain firm therefore become

$$\begin{aligned} b'_B &= b_B \left(1 - S_{IBO}(p_B - p_O + OF_{IBO})\right) + \\ &\quad + b_O \left(S_{IOB}(p_O - p_B + OF_{IOB})\right) \end{aligned} \tag{6.10}$$

$$\begin{aligned} b'_O &= b_O \left(1 - S_{IOB}(p_O - p_B + OF_{IOB})\right) + \\ &\quad + b_B \left(S_{IBO}(p_B - p_O + OF_{IBO})\right) \end{aligned} \tag{6.11}$$

Equation 6.10 is composed of two parts. The first part represents the number of consumers in the offline channel who are not switching to the online channel. The second part shows the number of consumers of the online channel migrating to the offline channel. Equation 6.11 depicts the same facts for the online channel. The first line represents online consumers not moving away from the online channel and the second line in the equation gives those consumers which drift towards the online channel from the offline channel.

6.3 Inter-Firm Switching

The model also allows consumers to switch from a certain channel of firm 1 to any channel of firm 2, e.g. a consumer is able to switch from the online channel of firm 1 to the offline channel of firm 2 at a predefined probability. Thus, each individual firm has to manage four additional switching issues.

S_{FBB} Switching probability from the offline channel of one firm to the offline channel of the competitor. The offset determining the price advantage of the competitor's offline channel versus the current firm's offline channel is denoted by OF_{FBB}.

S_{FBO} Switching probability from the offline channel to the online channel of the alternative firm. The channel advantage of the alternative firm's online channel is denoted by OF_{FBO}

S_{FOO} Switching probability from the online channel of the current firm to the online channel of the alternative firm. The corresponding channel offset is determined by OF_{FOO}

S_{FOB} Switching probability from the online channel to the competitor's offline channel. The appropriate offset for the competitor's price advantage in the offline channel is represented by OF_{FOB}

The basic equation turns out to be similar to Equation 6.9. Thus, we get for example the fraction of firm 1's offline consumers not switching from the offline channel of firm 1 to the online channel of firm 1, or to the offline channel of firm 2, or to the online channel of firm 2, i.e. those consumers who finally stay in firm 1's offline channel, by

$$\begin{aligned} b'_{B_1} &= b_B\,(1 - S_{IBO}(p_{B_1} - p_{O_1} + OF_{IBO})) \\ &\quad \cdot (1 - S_{FBB}(p_{B_1} - p_{B_2} + OF_{FBB})) \\ &\quad \cdot (1 - S_{FBO}(p_{B_1} - p_{O_2} + OF_{FBO})) \end{aligned} \tag{6.12}$$

Equation 6.12 gives, as mentioned, all consumers which are initially in the offline channel of firm 1 due to price reasons, and do not migrate to any alternative channel. Thus, the stringent condition $b'_{B_1} \leq b_B$ is fulfilled because each probability measure falls between zero and one. If no consumer changes to an alternative channel, all probability measures become 1, thus $b'_{B_1} = b_B$.

6.4 Assembling the Model

A picture says more than a thousand words. Therefore, Figure 6.3 gives an overview of all applicable switching probabilities. To keep it simple only the migration structure of the offline channel of firm 1 is shown. Figure 6.3 should

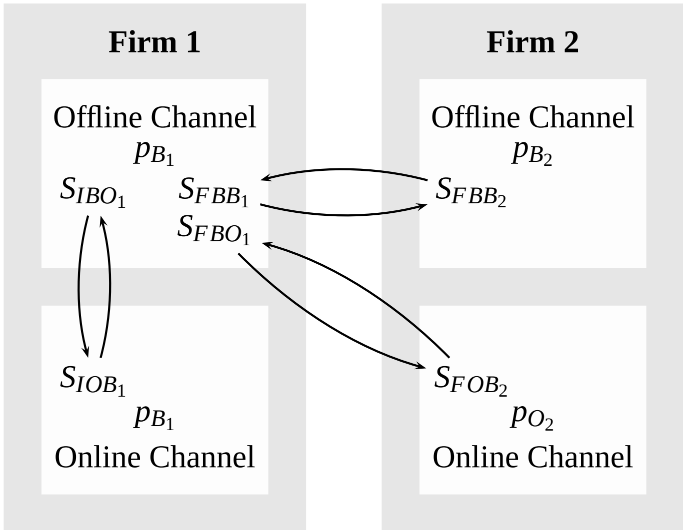

Figure 6.3: Switching Probabilities of the Online Channel Consumer Base of Firm 1

be read as follows. From the initial offline consumer base (see Equation 6.6) of firm 1, which is given by the offline price p_{B_1}, a fraction of S_{IBO_1} consumers change to the online channel of firm 1. Contrariwise S_{IOB_1} percentages of the initial online consumer base of firm 1 migrate towards its offline channel. The exchange of consumers between the offline channel of firm 1 and the offline channel of firm 2 works in a similar way. A fractional number of S_{FBB_1} consumers switch from the offline channel of firm 1 to the alternative offline channel of firm 2. On the other hand, a percentage of S_{FBB_2} of firm 2's basic offline consumers swap back to firm 1's offline channel and add to its consumer base. Finally, the drift of consumers from the offline channel of firm 1 to the online channel of firm 2 and vice versa follows a related procedure. S_{FBO_1} percentage of the basic offline consumer base switch to the online channel of firm 2, whereas S_{FOB_2} consumers migrate from firm 2's online channel to firm 1's offline channel.

To finish the complete equation for the final consumer base in each channel, the not-switching probabilities will be defined for readability reasons. Since the market environment is a duopoly, all equations are symmetric, i.e. an equation for firm 1 is also valid for firm 2 except for exchanged subscripts. Therefore, only equations for firm 1 are given because the corresponding equations for firm 2 could be easily deduced. The not-switching probabilities for firm 1 are

$$\begin{aligned}
si_{off\to on_1} &= 1 - S_{IBO_1}(p_{B_1} - p_{O_1} + OF_{IBO_1}) && (6.13)\\
si_{on\to off_1} &= 1 - S_{IOB_1}(p_{O_1} - p_{B_1} + OF_{IBO_1}) && (6.14)\\
sf_{off\to off_1} &= 1 - S_{FBB_1}(p_{B_1} - p_{B_2} + OF_{FBB_1}) && (6.15)\\
sf_{off\to on_1} &= 1 - S_{FBO_1}(p_{B_1} - p_{O_2} + OF_{FBO_1}) && (6.16)\\
sf_{on\to on_1} &= 1 - S_{FOO_1}(p_{O_1} - p_{O_2} + OF_{FOO_1}) && (6.17)\\
sf_{on\to off_1} &= 1 - S_{FOB_1}(p_{O_1} - p_{B_2} + OF_{FOB_1}) && (6.18)
\end{aligned}$$

Now we start to calculate the consumers for each channel. First, we calculate the initial consumer base for each channel corresponding to firm 1. For the initial consumer base it must be distinguished between consumers stemming from a price equal to the competitor's price or flocking to the firm due to a lower price than the competitor offers. Therefore, two distinct initial consumer bases are calculated

$$b^A_{B_1} = \begin{cases} \widehat{b_B}\,\frac{\left(1-R_B(p_{B_1})\right)}{2} & \forall p_{B_1} > p_{B_2} \\ \widehat{b_B}\,\frac{\left(1-R_B(p_{B_2})\right)}{2} & \forall p_{B_1} < p_{B_2} \end{cases} \tag{6.19}$$

$$\begin{aligned}
b^B_{B_1} &= \left[\widehat{b_B}\,(1 - R_B(p_{B_1})) - \widehat{b_B}\,(1 - R_B(p_{B_2}))\right] && (6.20)\\
b^B_{B_1} &= 0 \quad \forall p_{B_1} > p_{B_2}
\end{aligned}$$

$$b^A_{O_1} = \begin{cases} \widehat{b_O}\,\frac{\left(1-R_O(p_{O_1})\right)}{2} & \forall p_{O_1} > p_{O_2} \\ \widehat{b_O}\,\frac{\left(1-R_O(p_{O_2})\right)}{2} & \forall p_{O_1} < p_{O_2} \end{cases} \tag{6.21}$$

$$
\begin{aligned}
b_{O_1}^{B} &= \left[\widehat{b_O}\left(1-R_O(p_{O_1})\right)-\widehat{b_O}\left(1-R_O(p_{O_2})\right)\right] \\
b_{O_1}^{B} &= 0 \quad \forall p_{O_1} > p_{O_2}
\end{aligned} \tag{6.22}
$$

Equations 6.19 to 6.22 display the composition of the basic consumer bases for each channel. Parts $b_{B_1}^{A}$ and $b_{O_1}^{A}$ represent consumers which are shared with the competitor. If firm 1 prices its opponent price it will receive the shared part only. Otherwise firm 1 could get off with extra consumers due to its lower pricing. The basic consumer base part of Equation 6.20 and 6.22 representing optional extra consumers will become zero if firm 1 commands prices above its opponents' prices. $b_{B_1}^{B}$ and $b_{O_1}^{B}$ display the extra consumers obtained by firm 1 setting prices lower than firm 2. These consumer bases will not be shared with the opponent since it prices higher. The final consumer base of the offline channel of firm 1 is composed out of six parts.

$$
\begin{aligned}
b_{B_1} = \; & b_{B_1}^{A}\, si_{off\rightarrow on_1}\, sf_{off\rightarrow off_1}\, sf_{off\rightarrow on_1} + \\
& + b_{B_1}^{B}\, si_{off\rightarrow on_1} + \\
& + b_{O_1}^{A}\left(1-si_{on\rightarrow off_1}\right) sf_{on\rightarrow on_1}\, sf_{on\rightarrow off_1} + \\
& + b_{O_1}^{B}\left(1-si_{on\rightarrow off_1}\right) + \\
& + b_{B_2}^{A}\, si_{off\rightarrow on_2}\left(1-sf_{off\rightarrow off_2}\right) sf_{off\rightarrow on_2} + \\
& + b_{O_2}^{A}\, si_{on\rightarrow off_2}\, sf_{on\rightarrow on_2}\left(1-sf_{on\rightarrow off_2}\right)
\end{aligned} \tag{6.23}
$$

The six parts, each line representing one single part, of Equation 6.32 could be described as follows

- All initial consumers of the offline channel of firm 1 who are not switching to the online channel of firm 1, who are not migrating to the offline channel of firm 2 and who are also not migrating to the online channel of firm 2.

- All initial extra consumer of the offline channel of firm 1 (those who are obtained due to lower prices) who are not changing to the online channel of firm 1.

- All initial consumers of the online channel of firm 1 who are neither switching to the online nor to the offline channel of firm 2, but are indeed migrating to the offline channel of firm 1.
- All initial extra consumers of the online channel of firm 1 who are drifting to the offline channel of the same firm.
- All initial consumers of the offline channel of firm 2 who are neither switching to its own online channel nor switching to online channel of firm 1, but indeed drifting to the offline channel of firm 1.
- All initial consumers of the online channel of firm 2 who are neither migrating to its own offline channel nor migrating to the online channel of firm 1, but indeed switching to the offline channel of firm 1

The final consumer base of the online channel of firm 1 is composed in a very similar way and becomes

$$\begin{aligned} b_{O_1} = \; & b^A_{O_1}\, si_{on\to off_1}\, sf_{on\to on_1}\, sf_{on\to off_1} + \\ & + b^B_{O_1}\, si_{on\to off_1} + \\ & + b^A_{B_1}\left(1 - si_{off\to on_1}\right) sf_{off\to off_1}\, sf_{off\to on_1} + \\ & + b^B_{B_1}\left(1 - si_{off\to on_1}\right) + \\ & + b^A_{O_2}\, si_{on\to off_2}\left(1 - sf_{on\to on_2}\right) sf_{on\to off_2} + \\ & + b^A_{B_2}\, si_{off\to on_2}\, sf_{off\to off_2}\left(1 - sf_{off\to on_2}\right) \end{aligned} \tag{6.24}$$

Equations 6.32 and 6.24 finally give the number of consumers in each sales channel attracted by the pricing. Thus, sales υ and profit π using costs c of firm 1 could be derived easily by

$$\upsilon_1 = b_{B_1}\, p_{B_1} + b_{O_1}\, p_{O_1} \tag{6.25}$$

$$\pi_1 = b_{B_1}\left(p_{B_1} - c_{B_1}\right) + b_{O_1}\left(p_{O_1} - c_{O_1}\right) \tag{6.26}$$

Equation 6.25 represents the total sales of firm 1 and Equation 6.26 the corresponding profit. Without loss of generality, fixed costs are assumed to be zero.

Only variable costs c lower the profit of the firm. Since variable costs may be different in each channel, each firm has to be aware of that issue (see Equation 6.26). The firms' objectives are pretty clear. Each firm wants to maximize its profit. The scope of options is limited to conduct pricing strategies in the online and in the offline channel since variable costs are given exogenously. The optimization problem for the firm 1 therefore becomes

$$\max_{p_{B_1}, p_{O_1}} \pi(p_{B_1}, p_{O_1}) \tag{6.27}$$

$$\text{s.t.}$$

$$p_{B_1}, p_{O_1} \geq 0 \tag{6.28}$$

$$p_{B_1}, p_{O_1} \leq 1 \tag{6.29}$$

Equation 6.27 states the mathematical optimization problem with conditions limiting the price levels. Thus, the firm maximizes its profit by setting prices between zero and one.

From this view, each firm has to manage three different effects. At first, it has to handle the consumer switching effect. This effect describes the switching from, say, firm 2 to firm 1 due to price cuts. Firms have to consider how much to charge for a certain product to draw consumers away from its competitor. The second impact factor relates to the market expansion effect. Depending on consumers' willingness to pay, firms should evaluate their pricing. The quest is to find a price to attract the maximum of consumers at a price which is profit maximizing. The main focus of this effect lies on acquiring consumers. The third important factor is the cannibalization effect. Since each firm offers its product in both sales channels, different prices may occur and consumers may migrate from the one channel to the alternative channel within the same firm. Thus, firms have to carefully consider in which channel to offer a product and how to price it. The model also allows to quantify the cannibalization effect. On the one hand a firm may suffer a loss from consumers switching from the entrenched offline channel to the new online channel. On the other hand this loss may be outweighed by the gain from acquiring new consumers through the online channel. The cannibalization loss for firm 1 Can_{L_1} therefore becomes

$$\begin{aligned} Can_{L_1} &= \left(p_{B_1} - p_{O_1}\right)\left(b^A_{B_1}\left(1 - si_{off\rightarrow on_1}\right) sf_{off\rightarrow off_1}\, sf_{off\rightarrow on_1} + \right. \\ &\left. + b^B_{B_1}\left(1 - si_{off\rightarrow on_1}\right)\right) \end{aligned} \tag{6.30}$$

Equation 6.30 displays consumers switching from the offline channel to the online channel of firm 1 and therefore receiving a different potentially lower price. Since prices may be different in both channels, the loss could even become positive, i.e. a profit, if the price in the online is located above the offline price $p_{B_1} < p_{O_1}$. The opposite, the cannibalization gain of firm 1 Can_{P_1} becomes

$$\begin{aligned} Can_{P_1} &= p_{O_1}\left(b^A_{O_1}\, si_{on\rightarrow off_1}\, sf_{on\rightarrow on_1}\, sf_{on\rightarrow off_1} + \right. \\ &+ b^B_{O_1}\, si_{on\rightarrow off_1} + \\ &+ b^A_{O_2}\, si_{on\rightarrow off_2}\left(1 - sf_{on\rightarrow on_2}\right) sf_{on\rightarrow off_2} + \\ &\left. + b^A_{B_2}\, si_{off\rightarrow on_2}\, sf_{off\rightarrow off_2}\left(1 - sf_{off\rightarrow on_2}\right)\right) + \\ &+ p_{B_1}\left(b^A_{O_1}\left(1 - si_{on\rightarrow off_1}\right) sf_{on\rightarrow on_1}\, sf_{on\rightarrow off_1} + \right. \\ &\left. + b^B_{O_1}\left(1 - si_{on\rightarrow off_1}\right)\right) \end{aligned} \tag{6.31}$$

Equation 6.31 shows the total profit by introducing the online channel. The first part (multiplied by p_{O_1}) gives the consumers attracted by the new channel. This part is composed of online consumers attracted plus consumers migrating from firm 2 towards firm 1's online channel. The second part displays the number of consumers switching from the online channel to the offline channel and therefore purchasing at p_{O_1}. The online channel enables these consumers for the offline channel. The total cannibalization effect of firm 1 Can_1 results in

$$Can_1 = Can_{P_1} - Can_{L_1} \tag{6.32}$$

The "pure" cannibalization, i.e. the inter-firm cannibalization is composed of the following. The cannibalization loss is equal to Equation 6.30 since only consumers switching from the offline channel to the online channel are taken into account. The pure cannibalization profit Can_{O_1} of the online channel is made up of those consumers migrating from the online channel to the offline channel of the same firm.

$$
\begin{aligned}
Can_{O_1} &= (p_{O_1} - p_{B_1})\left(b^A_{O_1}\left(1 - si_{on\to off_1}\right) sf_{on\to on_1} sf_{on\to off_1} + \right. \\
&\quad \left. + b^B_{O_1}\left(1 - si_{on\to off_1}\right)\right) \qquad (6.33)
\end{aligned}
$$

6.5 Expected Value

Since the whole economy is described by various distributions one could calculate the expected value, i.e. the expected profit of a certain firm. First, define the expected consumer bases for each firm on the basis of its prices, i.e. the expected consumers which show a reservation price higher than the price offered by the firm. We have to distinguish between two situations. The first is represented by firm 1's prices below firm 2's prices. Thus, firm 1 could earn some extra consumers. The opposite situation emerges if firm 1 offers prices above firm 2. The resulting consumers will be shared equally between firm 1 and firm 2 (see Equations 6.19, 6.20, 6.21 and 6.22). The expected basic consumer bases for firm 1 become

$$
\begin{aligned}
\mathbf{E}[b^A_{B_1}] &= \begin{cases} \frac{1-\mathbf{E}[R_B|p_{B_1}]}{2} & \forall p_{B_1} > p_{B_2} \\ \frac{1-\mathbf{E}[R_B|p_{B_2}]}{2} & \forall p_{B_1} \leq p_{B_2} \end{cases} \\
\mathbf{E}[b^B_{B_1}] &= \begin{cases} (1-\mathbf{E}[R_B|p_{B_1}]) - (1-\mathbf{E}[R_B|p_{B_2}]) & \forall p_{B_1} < p_{B_2} \\ 0 & \forall p_{B_1} \geq p_{B_2} \end{cases} \\
\mathbf{E}[b^A_{O_1}] &= \begin{cases} \frac{1-\mathbf{E}[R_O|p_{O_1}]}{2} & \forall p_{O_1} > p_{O_2} \\ \frac{1-\mathbf{E}[R_O|p_{O_2}]}{2} & \forall p_{O_1} \leq p_{O_2} \end{cases} \\
\mathbf{E}[b^B_{O_1}] &= \begin{cases} (1-\mathbf{E}[R_O|p_{O_1}]) - (1-\mathbf{E}[R_O|p_{O_2}]) & \forall p_{O_1} < p_{O_2} \\ 0 & \forall p_{O_1} \geq p_{O_2} \end{cases}
\end{aligned} \qquad (6.34)
$$

For better readability let each expected value $\mathbf{E}[S_{\cdot}]$ be conditioned on its subscripts, i.e. $\mathbf{E}[S_{IBO_1}] \equiv \mathbf{E}[S_{IBO_1}|p_{B_1} - p_{O_1}]$ or $\mathbf{E}[S_{FBB_2}] \equiv \mathbf{E}[S_{FBB_2}|p_{B_2} - p_{B_1}]$. Therefore, the expected consumer base for the offline channel of firm 1 becomes

$$\begin{aligned}
\mathbf{E}[b_{B_1}] \quad = \quad & \mathbf{E}[b^A_{B_1}]\big((1-\mathbf{E}[S_{IBO_1}])\,(1-\mathbf{E}[S_{FBB_1}])\,(1-\mathbf{E}[S_{FBO_1}])\big)+ \\
& +\mathbf{E}[b^B_{B_1}]\,(1-\mathbf{E}[S_{IBO_1}])+ \\
& +\mathbf{E}[b^A_{O_1}]\big(\mathbf{E}[S_{IOB_1}]\,(1-\mathbf{E}[S_{FOO_1}])\,(1-\mathbf{E}[S_{FOB_1}])\big)+ \\
& +\mathbf{E}[b^B_{O_1}]\,\mathbf{E}[S_{IOB_1}]+ \\
& +\mathbf{E}[b^A_{B_2}]\big((1-\mathbf{E}[S_{IBO_2}])\,\mathbf{E}[S_{FBB_2}]\,(1-\mathbf{E}[S_{FBO_2}])\big)+ \\
& +\mathbf{E}[b^A_{O_2}]\big((1-\mathbf{E}[S_{IOB_2}])\,(1-\mathbf{E}[S_{FOO_2}])\,\mathbf{E}[S_{FOB_2}]\big)
\end{aligned} \tag{6.35}$$

The corresponding expected consumer base for the online channel looks like

$$\begin{aligned}
\mathbf{E}[b_{O_1}] \quad = \quad & \mathbf{E}[b^A_{O_1}]\big((1-\mathbf{E}[S_{IOB_1}])\,(1-\mathbf{E}[S_{FOO_1}])\,(1-\mathbf{E}[S_{FOB_1}])\big)+ \\
& +\mathbf{E}[b^B_{O_1}]\,(1-\mathbf{E}[S_{IOB_1}])+ \\
& +\mathbf{E}[b^A_{B_1}]\big(\mathbf{E}[S_{IBO_1}]\,(1-\mathbf{E}[S_{FBB_1}])\,(1-\mathbf{E}[S_{FBO_1}])\big)+ \\
& +\mathbf{E}[b^B_{B_1}]\,\mathbf{E}[S_{IBO_1}]+ \\
& +\mathbf{E}[b^A_{O_2}]\big((1-\mathbf{E}[S_{IOB_2}])\,\mathbf{E}[S_{FOO_2}]\,(1-\mathbf{E}[S_{FOB_2}])\big)+ \\
& +\mathbf{E}[b^A_{B_2}]\big((1-\mathbf{E}[S_{IBO_2}])\,(1-\mathbf{E}[S_{FBB_2}])\,\mathbf{E}[S_{FBO_2}]\big)
\end{aligned} \tag{6.36}$$

Equations 6.35 and 6.36 resulting in the expected profit of firm 1 could be written as

$$\mathbf{E}[\pi] \quad = \quad \mathbf{E}[b_{B_1}]\,(p_{B_1}-c_{B_1})+\mathbf{E}[b_{O_1}]\,(p_{O_1}-c_{O_1}) \tag{6.37}$$

We are also able to quantify the expected cannibalization loss of firm 1 $\mathbf{E}[Can_{L_1}]$ by

$$\begin{aligned}
\mathbf{E}[Can_{L_1}] \quad = \quad & (p_{B_1}-p_{O_1})\cdot \\
& \cdot\big(\mathbf{E}[b^A_B]\,\mathbf{E}[S_{IBO_1}]\,(1-\mathbf{E}[S_{FBB_1}])\,(1-\mathbf{E}[S_{FBO_1}])+ \\
& +\mathbf{E}[b^B_{B_1}]\,\mathbf{E}[S_{IBO_1}]\big)
\end{aligned} \tag{6.38}$$

But this forms only one side of the coin. The loss of consumers switching from the offline channel to the online channel may be outweighed by the profit from introducing the alternative online channel. The expected cannibalization profit of firm 1 $\mathbf{E}[Can_{P_1}]$ therefore becomes

$$\begin{aligned}
\mathbf{E}[Can_{P_1}] \quad = \quad & p_{O_1}\big(\mathbf{E}[b^A_{O_1}]\,(1-\mathbf{E}[S_{IOB_1}])\,(1-\mathbf{E}[S_{FOO_1}])\,(1-\mathbf{E}[S_{FOB_1}])+\\
& +\mathbf{E}[b^B_{O_1}]\,(1-\mathbf{E}[S_{IOB_1}])+\\
& +\mathbf{E}[b^A_{O_2}]\,(1-\mathbf{E}[S_{IOB_2}])\,\mathbf{E}[S_{FOO_2}]\,(1-\mathbf{E}[S_{FOB_2}])+\\
& +\mathbf{E}[b^A_{B_2}]\,(1-\mathbf{E}[S_{IBO_2}])\,(1-\mathbf{E}[S_{FBB_2}])\,\mathbf{E}[S_{FBO_2}]\big)+\\
& +p_{B_1}\left(\mathbf{E}[b^A_{O_1}]\,\mathbf{E}[S_{IOB_1}]\,(1-\mathbf{E}[S_{FOO_1}])\,(1-\mathbf{E}[S_{FOB_1}])+\right.\\
& \left.+\mathbf{E}[b^B_{O_1}]\,\mathbf{E}[S_{IOB_1}]\right) \qquad (6.39)
\end{aligned}$$

An obvious result emerges immediately from Equations 6.38 and 6.39. If the firm could command equal prices in both channels, the online channel exhibits a positive return. The cannibalization effect will also result in a positive value since $\mathbf{E}[Can_{L_1}] = 0$ and $\mathbf{E}[Can_{P_1}] > 0$. Thus, introducing the additional online channel will be profitable for a firm.

The above-mentioned equations (Equations 6.34–6.39) allow us to conduct theoretical considerations for certain pricing conditions. The considerations are all based on firm 1's view.

Lowest Price Offline

The first environment to analyze is one with a pricing structure where firm 1's offline price is lowest and all other prices are equal, i.e. $p_{B_1} < p_{O_1} = p_{B_2} = p_{O_2}$. Firm 1 offers a competitive price in the offline channel, i.e. a certain number of consumers should migrate from firm 2's sales channels as well as from firm 1's online channel towards firm 1's offline channel. Further, due to the lower price in the offline channel, firm 1 generates extra consumers holding reservation prices between firm 1's offline price and all other prices. These consumers are denoted by $\mathbf{E}[b_{B_1}^B]$ and not shared with the competitor.

$$\begin{aligned}
\mathbf{E}[b_{B_1}] &= \mathbf{E}[b_{B_1}^A] + \mathbf{E}[b_{B_1}^B] + \mathbf{E}[b_{O_1}^A]\,\mathbf{E}[S_{IOB_1}] + \\
&\quad + \mathbf{E}[b_{B_2}^A]\,\mathbf{E}[S_{FBB_2}] + \mathbf{E}[b_{O_2}^A]\,\mathbf{E}[S_{FOB_2}] \\
\mathbf{E}[b_{O_1}] &= \mathbf{E}[b_{O_1}^A]\,(1 - \mathbf{E}[S_{IOB_1}]) \\
\mathbf{E}[Can_{L_1}] &= 0 \\
\mathbf{E}[Can_{P_1}] &= p_{O_1}\,\mathbf{E}[b_{O_1}^A]\,(1 - \mathbf{E}[S_{IOB_1}]) + p_{B_1}\,\mathbf{E}[b_{O_1}^A]\,\mathbf{E}[S_{IOB_1}]
\end{aligned}$$

Equations 6.40 show the expected values for online and offline consumers and cannibalization figures of firm 1. First to note is that due the given pricing structure $\mathbf{E}[b_{B_1}^A] = \mathbf{E}[b_{B_2}^A]$ and $\mathbf{E}[b_{O_1}^A] = \mathbf{E}[b_{O_2}^A]$. Next, a few words on the optimal profit. If $p_{B_1} = p_{O_1} = p_X$ all switching erodes and the profit results in $\mathbf{E}[\pi] = p_X\,\mathbf{E}[b_{B_X}^A] + p_X\,\mathbf{E}[b_{O_X}^A]$. Note that p_X is a proxy for any price since all prices are assumed to be equal in the first step. Further, note that $\mathbf{E}[b_{B_X}^A]$ is equal for all firms too. Also note that costs are neglected for better readability. If the offline price of firm 1 is decreased, the following profit function (again neglecting costs) is valid

$$\begin{aligned}
\mathbf{E}[\pi] &= p_{B_1}\,\mathbf{E}[b_{B_X}^A] + \\
&\quad + p_{B_1}\left(\mathbf{E}[b_{B_1}^B] + \mathbf{E}[b_{O_X}^A]\,(\mathbf{E}[S_{IOB_1}] + \mathbf{E}[S_{FOB_2}]) + \right. \\
&\quad \left. + \mathbf{E}[b_{B_X}^A]\,\mathbf{E}[S_{FBB_2}]\right) + \\
&\quad + p_X\,\mathbf{E}[b_{O_X}^A]\,(1 - \mathbf{E}[S_{IOB_1}])
\end{aligned} \tag{6.40}$$

From Equation 6.40 we could deduce the following relations $p_{B_1}\,\mathbf{E}[b_{B_X}^A] < p_X\,\mathbf{E}[b_{B_X}^A]$ and $\mathbf{E}[b_{O_X}^A]\,(1 - \mathbf{E}[S_{IOB_1}]) < p_X\,\mathbf{E}[b_{O_X}^A]$, therefore the optimizing process should rely on the remaining parts of the profit equation. The strategy to maximize profits is one between setting the offline price equal to all other prices and offering an offline price near to zero. If we let p_{B_1} run to zero the number of consumers are maximized but profits will also run towards zero. The profit maximizing offline price is determined by the internal switching probability and the probability of consumers of firm 2 migrating to firm 1's offline channel. The cannibalization profit is also bound between both extreme values. At equal prices the cannibalization profit amounts to $p_X\,\mathbf{E}[b^A_{O_X}]$. With an offline price of zero the cannibalization profit also erodes and approaches zero. Here the maximum is much easier to detect because it depends on the intra-firm switching probability, i.e. the probability of firm 1's online consumers migrating towards its offline channel subject to the offline price. The cannibalization loss should certainly be zero, since the online price is higher than the offline price and therefore no switching from the offline channel towards the online channel occurs.

Highest Price Offline

The opposite scenario emerges when firm 1 commands the highest price in the offline channel, i.e. $p_{B_1} > p_{O_1} = p_{B_2} = p_{O_2}$. All extra rents of consumers due to lower prices nullify, i.e. $\mathbf{E}[b^B_{B_1}] = \mathbf{E}[b^B_{O_1}] = 0$. For the other consumers which may purchase at firm 1 all switching probabilities kick in and further drive consumers away from firm 1.

$$
\begin{aligned}
\mathbf{E}[b_{B_1}] &= \mathbf{E}[b^A_{B_1}]\left((1-\mathbf{E}[S_{IBO_1}])\,(1-\mathbf{E}[S_{FBB_1}])\,(1-\mathbf{E}[S_{FBO_1}])\right)\\
\mathbf{E}[b_{O_1}] &= \mathbf{E}[b^A_{O_1}] + \mathbf{E}[b^A_{B_1}]\left(\mathbf{E}[S_{IBO_1}]\,(1-\mathbf{E}[S_{FBB_1}])\,(1-\mathbf{E}[S_{FBO_1}])\right)\\
\mathbf{E}[Can_{L_1}] &= (p_{B_1}-p_{O_1})\cdot\\
&\quad\cdot\left(\mathbf{E}[b^A_B]\,\mathbf{E}[S_{IBO_1}]\,(1-\mathbf{E}[S_{FBB_1}])\,(1-\mathbf{E}[S_{FBO_1}])\right)\\
\mathbf{E}[Can_{P_1}] &= p_{O_1}\,\mathbf{E}[b^A_{O_1}] \qquad (6.41)
\end{aligned}
$$

Equations 6.41 depict expected consumers for each channel and expected cannibalization losses and gains. For some deeper analysis it may also be interesting to start with an extreme case. Let $p_{B_1} = p_{O_1} = p_X$ and therefore the resulting profit becomes $\mathbf{E}[\pi] = p_X\,\mathbf{E}[b^A_{B_X}] + p_X\,\mathbf{E}[b^A_{O_X}]$. Two things are clear. First, offline consumers are lower if the offline price is higher, i.e. $\mathbf{E}[b^A_{B_X}] > \mathbf{E}[b_{B_1}]$. Second, online consumers increase by the number of consumers switching from the offline channel to the online channel, i.e. $\mathbf{E}[b^A_{O_X}] < \mathbf{E}[b_{O_1}]$. The overall effect is not clear. Depending on the switching structure and the offline price, profits may be higher compared to an environment where all prices are equal. Regarding cannibalization a loss is observed. This is very natural since consumers capitalize on the price advantage of the online channel and migrate from firm 1's offline channel towards its online channel. The cannibalization loss could be minimized if the offline prices converge to the online price. If both prices are equal, the cannibalization loss is nullified. Indeed, one could observe that with both prices equal, the cannibalization effect, i.e. the sum of profit and loss, could be maximized. For each $p_{B_1} > p_{O_1}$ the cannibalization loss is larger than zero and lowers the positive cannibalization effect.

Lowest Prices Firm 1

This pricing should be the most competitive one. Firm 1 in both channel prices below its competitor, i.e. $p_{B_1} = p_{O_1} < p_{B_2} = p_{O_2}$. Both channels capture extra consumers by undercutting firm 2's prices. In this scenario consumers migrate from firm 2 to firm 1 but not vice versa. Additionally no intra-firm switching should occur since both prices of firm 1 are equal.

$$\begin{aligned}
\mathbf{E}[b_{B_1}] &= \mathbf{E}[b^A_{B_1}] + \mathbf{E}[b^B_{B_1}] + \\
&\quad + \mathbf{E}[b^A_{B_2}]\,\mathbf{E}[S_{FBB_2}]\,(1 - \mathbf{E}[S_{FBO_2}]) + \\
&\quad + \mathbf{E}[b^A_{O_2}]\,(1 - \mathbf{E}[S_{FOO_2}])\,\mathbf{E}[S_{FOB_2}] \\
\mathbf{E}[b_{O_1}] &= \mathbf{E}[b^A_{O_1}] + \mathbf{E}[b^B_{O_1}] + \\
&\quad + \mathbf{E}[b^A_{O_2}]\,\mathbf{E}[S_{FOO_2}]\,(1 - \mathbf{E}[S_{FOB_2}]) + \\
&\quad + \mathbf{E}[b^A_{B_2}]\,(1 - \mathbf{E}[S_{FBB_2}])\,\mathbf{E}[S_{FBO_2}] \\
\mathbf{E}[Can_{L_1}] &= 0 \\
\mathbf{E}[Can_{P_1}] &= p_{O_1}\big(\mathbf{E}[b^A_{O_1}] + \mathbf{E}[b^B_{O_1}] + \\
&\quad + \mathbf{E}[b^A_{O_2}]\,\mathbf{E}[S_{FOO_2}]\,(1 - \mathbf{E}[S_{FOB_2}]) + \\
&\quad + \mathbf{E}[b^A_{B_2}]\,(1 - \mathbf{E}[S_{FBB_2}])\,\mathbf{E}[S_{FBO_2}]\big)
\end{aligned} \tag{6.42}$$

Equations 6.43 again express expected values of interest. Regarding the profit it is obvious that compared to equal prices ($p_{B_1} = p_{O_1} = p_X$) the profit reached by the current strategy is larger. The profit surplus is composed of extra consumers in both channels as well as switching consumers. The nullification of the cannibalization loss is also no surprise. Both channels of firm 1 offer the same prices, therefore intra-firm switching will not occur. Therefore, the cannibalization profit is composed of the profit made by the online channel. So it is enough to maximize the cannibalization profit since the total profit should be maximal too.

Highest Prices Firm 1

The last scenario is the most unfortunate for firm 1. Here firm 2 prices both channels below firm 1, i.e. $p_{B_1} = p_{O_1} > p_{B_2} = p_{O_2}$. So firm 1 is not capable to attract any extra consumers, even worse, from the existing consumers a certain fraction migrates to firm 2. That strategy should be neither competitive nor profit maximizing.

$$\begin{aligned}
\mathbf{E}[b_{B_1}] &= \mathbf{E}[b^A_{B_1}]\,(1-\mathbf{E}[S_{FBB_1}])\,(1-\mathbf{E}[S_{FBO_1}]) \\
\mathbf{E}[b_{O_1}] &= \mathbf{E}[b^A_{O_1}]\,(1-\mathbf{E}[S_{FOO_1}])\,(1-\mathbf{E}[S_{FOB_1}]) \\
\mathbf{E}[Can_{L_1}] &= 0 \\
\mathbf{E}[Can_{P_1}] &= p_{O_1}\left(\mathbf{E}[b^A_{O_1}]\,(1-\mathbf{E}[S_{FOO_1}])\,(1-\mathbf{E}[S_{FOB_1}])\right)
\end{aligned} \tag{6.43}$$

Equations 6.43 give an overview of some interesting expected values. If we again start by assuming $p_{B_1} = p_{O_1} = p_X$, therefore letting the resulting profit become $\mathbf{E}[\pi] = p_X\,\mathbf{E}[b^A_{B_X}] + p_X\,\mathbf{E}[b^A_{O_X}]$, we could immediately find the loss firm 1 suffers by the current strategy. Each value of $\mathbf{E}[b^A_{B_X}]$ and $\mathbf{E}[b^A_{O_X}]$ is reduced by consumers migrating to firm 2. Therefore, this strategy is the least profitable one. Since both prices of firm 1 are again equal it suffers no cannibalization loss. The cannibalization profit is composed of the profit earned from the online channel. All earnings from the online channel are additional profits by the introduction of the online channel and therefore regarded as cannibalization profit.

In that basic model certain things appear to be noteworthy. First of all, if a firm could command equal prices in its sales channels it should do so. By this strategy the cannibalization loss is minimized and the firm finds itself on the safe side by earning profits from the development of the online channel. Second, although it is clear for a strategy of overpricing which is the least profitable way of doing business, all other strategies do not give such a clear picture. The profit-maximizing strategy relies heavily on the switching probabilities and certainly the reservation prices itself. So no recommendation could be deduced at this time. Which strategy to implement may be a matter of the product, which defines its own market structure including all reservation prices and switching probabilities.

6.6 Price Elasticity

To give a complete overview of the model, the price elasticities subject to the offline price of firm 1 are calculated. The price elasticity gives the percentage consumer change on a one percent price change. This measure could give some insight into the market behavior and consumers' sensitivity towards prices.
Since the online channel could be regarded as the opposite of the offline channel, calculations are restricted to the offline channel only. The complete derivative is also very elusory, therefore certain situations are analyzed. Note that this elasticity is calculated from the first derivative of the corresponding demand function subject to the offline price.

Lowest Price Offline

The first interesting question may be a situation when firm 1's offline price is lowest, i.e. $p_{B_1} < p_{O_1} = p_{B_2} = p_{O_2}$. Therefore, all other prices except firm 1's offline price are denoted by p_X.

$$\begin{aligned} b_{B_1} &= \frac{1}{2}\left(1-R_B(p_X)\right)+ \\ &\quad + \left(1-R_B(p_B)\right)-\left(1-R_B(p_X)\right)\left(1-S_{IBO_1}(p_B-p_X)\right)+ \\ &\quad + \frac{1}{2}\left(1-R_O(p_X)\right)\left(1-\left(1-S_{IOB_1}(p_X-p_B)\right)\right)+ \\ &\quad + \frac{1}{2}\left(1-R_B(p_X)\right)\left(1-\left(1-S_{FBB_2}(p_X-p_B)\right)\right)+ \\ &\quad + \frac{1}{2}\left(1-R_O(p_X)\right)\left(1-\left(1-S_{FOB_2}(p_X-p_B)\right)\right) \end{aligned} \tag{6.44}$$

Equation 6.44 gives the demand function for the current situation, i.e. the number of consumers which could be obtained in the offline channel. The corresponding elasticity subject to the offline price is given by the first derivative of this function with respect to firm 1's offline price. Some interesting features of that function should be mentioned. First, since the offline price is lowest, no consumer has an intention to migrate from firm 1's offline channel to any alternative channel. That is to say that the switching probabilities $S_{IBO_1}(p_B - p_X)$, $S_{FBB_1}(p_B - p_X)$ and $S_{FBO_1}(p_B - p_X)$ all become zero. Second, due to the low offline price firm 1 earns some extra consumers in the offline channel. This issue is calculated in the second row of Equation 6.44. Third, we see consumers migrating from all other channels towards firm 1's offline channel due to its lower price. Equation 6.44 shows that fact in the third to fifth rows.

$$
\begin{aligned}
\frac{\partial b_{B_1}}{\partial p_B} = & -\left(\frac{\partial R_B(p_B)}{\partial p_B}\right)+ \\
& +\frac{1}{2}\left((1-R_O(p_X))\left(\frac{\partial S_{IOB_1}(p_X-p_B)}{\partial p_B}\right)\right)+ \\
& +\frac{1}{2}\left((1-R_O(p_X))\left(\frac{\partial S_{FOB_2}(p_X-p_B)}{\partial p_B}\right)\right)+ \\
& +\frac{1}{2}\left((1-R_B(p_X))\left(\frac{\partial S_{FBB_2}(p_X-p_B)}{\partial p_B}\right)\right)
\end{aligned}
\tag{6.45}
$$

Equation 6.45 displays the price elasticity for a situation where firm 1 prices lowest in its offline channel. Note that the derivative of a cumulative probability function results in the corresponding density function. Since price elasticities are always less than zero, i.e. an increases in prices leads to a decrease in sales, the only negative part of the elasticity is the one which corresponds to extra consumers. This outcome should not be surprising because for these consumers firm 1's offline price is relevant, all other consumers come from the pricing in alternative channels. Therefore, the elasticity of switching consumers decreases price elasticity in the offline channel. Naturally, the number of switching consumers is influenced by the level of the offline price relative to alternative prices. Interestingly, that issue seems not to intensify the price elasticity in the offline channel. Thus, price elasticity in such a situation should be relatively low compared to the next situation.

Highest Price Offline

In that situation firm 1 prices its offline channel above all alternative channels, i.e. $p_{B_1} > p_{O_1} = p_{B_2} = p_{O_2}$. Again, all other prices are denoted by p_X for the sake of simplicity.

$$\begin{aligned} b_{B_1} &= \frac{1}{2}\left(1-R_B(p_B)\right)\left(1-S_{IBO_1}(p_B-p_X)\right)\left(1-S_{FBB_1}(p_B-p_X)\right)\cdot \\ &\quad \cdot\left(1-S_{FBO_1}(p_B-p_X)\right) \end{aligned} \tag{6.46}$$

Equation 6.46 displays the corresponding demand function. Consider the huge differences compared to the previous situation. First, firm 1 shows no ability to attract extra consumers to its offline channel. The extra consumers are now at firm 2's offline channel since the price is lower there. Second, all switching probabilities from firm 1's offline channel towards any other channel are larger than zero and therefore remain in the equation. Third, since the offline price is highest in the environment, all switching probabilities towards the offline channel become zero, i.e. $S_{IOB}(p_X - p_B) = S_{FBB}(p_X - p_B) = S_{FOB}(p_X - p_B) = 0$. No consumer still intends to migrate from any other channel towards firm 1's offline channel. Fourth, the basic consumer base $\frac{1-R_B(p_B}{2}$ is now determined by firm 1's offline price. The largest price in a certain channel decides about the basic number of consumers for that channel, which in addition are equally shared between both firms (see Equations 6.19 and 6.20).

$$\begin{aligned}
\frac{\partial b_{B_1}}{\partial p_B} = & -\frac{1}{2}\left(\left(\frac{\partial R_B(p_B)}{\partial p_B}\right)(1-S_{IBO_1}(p_B-p_X))\,(1-S_{FBB_1}(p_B-p_X))\cdot\right. \\
& \left.\cdot\,(1-S_{FBO_1}(p_B-p_X))\right) - \\
& -\frac{1}{2}\left((1-R_B(p_B))\left(\frac{\partial S_{IBO_1}(p_B-p_X)}{\partial p_B}\right)(1-S_{FBB_1}(p_B-p_X))\cdot\right. \\
& \left.\cdot\,(1-S_{FBO_1}(p_B-p_X))\right) - \\
& -\frac{1}{2}\left((1-R_B(p_B))\,(1-S_{IBO_1}(p_B-p_X))\left(\frac{\partial S_{FBB_1}(p_B-p_X)}{\partial p_B}\right)\cdot\right. \\
& \left.\cdot\,(1-S_{FBO_1}(p_B-p_X))\right) - \\
& -\frac{1}{2}\left((1-R_B(p_B))\,(1-S_{IBO_1}(p_B-p_X))\,(1-S_{FBB_1}(p_B-p_X))\cdot\right. \\
& \left.\cdot\left(\frac{\partial S_{FBO_1}(p_B-p_X)}{\partial p_B}\right)\right)
\end{aligned} \tag{6.47}$$

Equation 6.47 gives the price elasticity for the current situation where firm 1 prices highest in its offline channel. This time the negative elasticity is evident. Note the important difference of the partial derivative of the offline reservation price distribution. The elasticity is composed of offline reservation prices and switching probabilities from the offline channel to any alternative channel. The sum of all these influences should further result in a much higher elasticity than in the prior situation.

Overall the results on the elasticity imply different elasticities regarding the current price level. We note that the price elasticity is a function of all prices in the market. For a certain channel the price in that channel is a determining factor, but the influence of the alternative prices changes with the relative price level of that channel. If a firm prices a channel below all other channels, it could expect minimal price elasticity, because migrating consumers still add to the consumers in the specific channel. Pricing above all alternative channels definitely increases the elasticity since consumers migrate towards cheaper alternatives.

Chapter 7

Basic Model - Refined

One additional refinement needs to be applied to the basic model discussed in Chapter 6. As noted earlier, certain parameters of the market environment, with exception of the reservation prices, could be influenced by firms by performing different marketing programs, e.g. enhancing web site usability may increase satisfaction and thereby raise sales, training sales personnel may result in satisfaction due to advanced counseling. Such marketing activities may alter the shape of the switching distributions in favor of a firm.
Therefore, the influence of marketing activities on the theoretical model will be derived. Afterwards all available marketing actions will be discussed in detail to emphasize the impact of each individual action.

7.1 Influence of Marketing

Numerous marketing activities could be set by a firm to attract consumers. Each separate action is proposed to cause different effects on consumers' perception of a certain channel. Thus, each firm $j = \{1,2\}$ has to manage a vector $M_j = \{m_i\}$, where $m_{\cdot i}$ determines expenses in a certain marketing activity i, for example widening the product portfolio in the offline channel, enhancing security in the online channel, etc. Each channel reacts differently to such investments. A widening of the product range in the online channel, for example, would keep consumers bound to that channel because alternative channels lack assortment (e.g., Li et al. 2007, Shankar et al. 2003).

The problem is that different product categories may put diverse weights on separate marketing activities. Therefore, a probability measure is defined to represent the likelihood of picking the, from the consumers' perspective, most desired marketing action. Assume all marketing options, i.e. those for the online channel and that for the offline channel, are ordered according to their value to the consumers, i.e. the most demanded activity first. The firm is not aware of that ranking and assigns to each activity a certain amount of money so that the total expenses per channel do not exceed one, i.e. $\sum_{i=1}^{n} m_i = 1$. Now the pecuniary effort is multiplied with the effect of each activity to the consumers. A Geometric distribution G is taken to assign to each marketing option the corresponding impact on consumers' behavior. The parameter p of this distribution gives the decay ratio of the marketing effort to influence consumers. A p value of one will assign the whole possible impact to the top-ranked desired marketing activity. Therefore, only financial spending in this activity will influence consumers in a favorable direction. The Geometric distribution could also be interpreted as the probability of a firm to meet consumers' demanded marketing activities in the correct order.

For the most desired action the probability measure would be $P[X = i] = p\,(1-p)^{i-1}$, where i indicates the ordered number of a certain marketing activity. So we define the impact probability of the ranked marketing activities of the offline channel by $I_B = \left\{P[X = i] = p\,(1-p)^{i-1}\right\}_{i=1}^{n}$. The impact probability is the same for all firms but different for each channel. Further, the impact probability for each channel is only influenced by those actions which indeed affect this particular channel. The definition of the impact limits results in one. Thus, overspending is possible but does not affect consumers.

Therefore, we end up with one vector M_j for the offline and the online channel of each firm denoting the financial spending into a certain marketing activity, and an impact probability different for each channel I_B and I_O.

Before we proceed with the evaluation of the impact on consumers, we truncate every over-investment, i.e. we redefine M_j to be

$$\xi_{M_j} = \min\left(M_j, I_B, I_O\right) \quad \forall j = \{1, 2\} \tag{7.1}$$

Equation 7.1 discards any investments which exceed the optimal investments given by I_B and I_O. Thus, each element m_i of M_j could at most be as large as the corresponding optimal value from I_B or I_O. The final effect on the offline switching probabilities therefore becomes

$$\xi_{B_j} = \frac{1}{I_B \bullet I_B} I_B \bullet M_j \quad \forall j = \{1,2\} \tag{7.2}$$

The result ξ_{B_j} of Equation 7.2 alters all corresponding switching probabilities in a favorable direction, i.e. in this case all switching probabilities leading away from the offline channel will become lessened. Therefore, only those marketing investments M_j are taken into account which indeed affect the offline channel. Note, although the sum of total spending is one in any case, the investment efficiency of a certain channel may exceed one. A firm may in an extreme case direct all its spending to just one particular channel and forgo the alternative channel. Thus, the marketing activities in that particular channel may be too much. Overinvestment will not be honored. The maximum obtainable marketing efficiency will be limited to one for each channel. ξ_{B_j} gives the positive impact of the marketing strategies, i.e. the switching probability should become less. For example, for the offline channel of firm 1, the following variations occur if the marketing activities prove to be accurate above 50 %. The switching probabilities S_{IBO_1}, S_{FBB_1} and S_{FBO_1} should all become more skewed to the right, i.e. the skewness of each distribution should become negative. That is to say, consumers in the offline channel show less affinity to migrate from the offline channel to any alternative channel. The final effect on the online switching probabilities becomes in a similar way

$$\xi_{O_j} = \frac{1}{I_O \bullet I_O} I_O \bullet M_j \quad \forall j = \{1,2\} \tag{7.3}$$

In Equation 7.3 also only these marketing expenditures kick in which influence the online channel.

Lohse and Spiller (1998) give a good overview of the impact of different marketing actions like promotion, navigation and information on consumers channel choice. The impact of well done marketing is not as strong as for prices but still present (Png 2004, Simon 1992, p. 139).

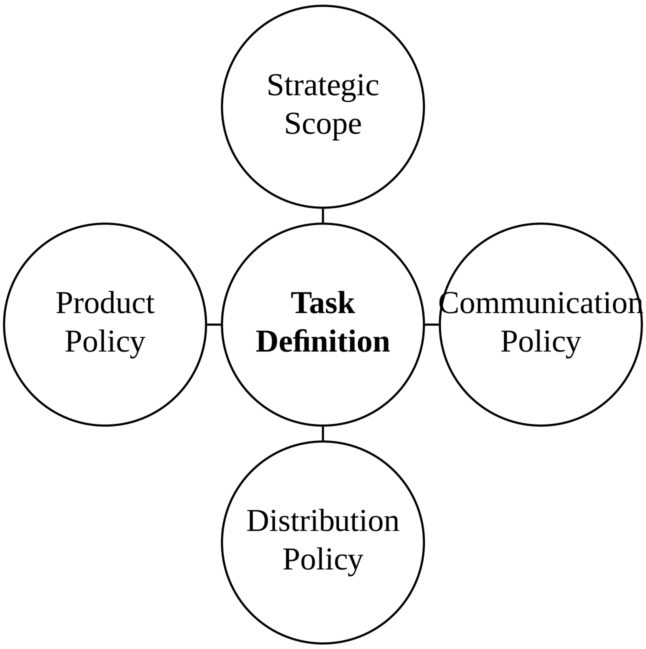

Figure 7.1: Additional Dimensions of the Refined Model (Hansen 2005)

Figure 7.1 displays a classification of alternative marketing efforts available in this study. Each individual marketing action of this dimension will be discussed in detail in the following section. The various marketing activities available are taken from current literature (Newman and Patel 2004, Holloway and Beatty 2008, Baker et al. 2002, Trocchia and Janda 2003, Janda et al. 2002).

7.1.1 Strategic Scope

The strategic scope describes fundamental decisions like the legal form of a company, location and target customers.

Convenience

Consumers' quest for convenience influences motivation to buy from a particular channel (e.g., Schoenbachler and Gordon 2002). Convenience in the offline channel relates to a parking lot near the store or the reachability of a traditional store. Lim and Dubinsky (2004) state that location, parking lots, the costs to move to the store, the location of items, and the acceptance of credit cards are important parameters describing convenience for offline stores.

In the online context convenience is regarded as shopping from home (e.g., Lim and Dubinsky 2004). Convenience seems to be more attributed to the online channel. Indeed, convenience was identified as the major benefit of the Internet (Litan and Rivlin 2001, Lim and Dubinsky 2004, Lohse and Spiller 1998). In the same vein, Keeney (1999) argued that a fundamental objective of online consumers is to maximize convenience. This is not surprising since consumers appear to find it more convenient and less costly to shop online (e.g., Reibstein 2002, Torkzadeh and Dhillon 2002). Further, inconvenience is often regarded as one of the major causes of service switching in the online context (e.g., Keaveney and Parthasarathy 2001).
Another convenience feature of the Internet becomes browsing through the assortment. Search behavior and online shopping are closely related in a positive manner, i.e. browsers often turn to buyers (e.g., Kim and Park 2005). Thus, online shopping is considered convenient for information searching, but sometimes regarded as too risky for purchasing (e.g., Alba et al. 1997, Verhoef et al. 2007). Bridges and Florsheim (2008) revealed that online consumers are more likely to purchase if their online experience is convenient. Finally, the ease of ordering from home is a major determinant of online shopping (e.g., Gehrt and Yan 2004). Also Donthu and Garcia (1999) found that internet shoppers are seeking more convenience. They emphasize the importance of convenience for the choice of the online channel.

Clientele

The clientele holds ambiguous meanings for each channel. In the physical retail store the social status of other consumers shopping in the same store is relevant. For some consumers this may be an important factor for deciding which store to shop at. In the context of the online shop the meaning becomes a little different. Since consumers could no longer really observe who is purchasing at a particular online shop they just could infer from hearsay or word-of-mouth social groups of the online store.
In case of physical retail stores, Balasubramanian et al. (2005) mentioned the quest for socialization when purchasing certain products. The presence of con-

sumers which share similar opinions and attitudes may increase utility and thus enhance satisfaction. A similar result is reported from Belk (1975), who mentioned social surroundings like other persons present influence shopping behavior. On the other hand personal hassle with sales personnel or other customers may become an obstacle to visiting the offline store (Chircu and Mahajan 2006).

7.1.2 Product Policy

This dimension represents decisions on the type of products offered, services like counseling, search agents, certificates, interactive help and guarantees, and assortment.

Counseling

Availability of proper counseling may be a decisive factor in preferring a particular sales channel. Balasubramanian et al. (2005) and Belk (1975) mentioned the quest for socialization when purchasing a certain product. Sales personnel are available for gossiping and some consumers may perceive an increased utility with such an option. Sales personnel attributes like friendliness, information services, advice and services are crucial factors for traditional stores (e.g., Verhoef et al. 2007, Lim and Dubinsky 2004). Hansen and Deutscher (1977) found that among the top ten attributes for department stores and grocery stores helpful personnel is demanded. They also found that an adequate number of personnel is necessary for grocery stores. The personality of the retailer, which is partly transported by its sales personnel, may therefore by an important factor for store choice (e.g., Gehrt and Yan 2004). Highly interpersonal channels could even reduce risk, i.e. a lot of communication might help to convince consumers and reduce their risk perception (e.g., Kumar and Venkatesan 2005)

On the contrary, personal hassle with sales personnel could be a limitation to offline shopping (e.g., Bakos 1997); even worse, if consumers dislike shopping in the offline environment and interacting with the sales personnel (e.g., Chircu and Mahajan 2006).

Bäckström and Johansson (2006) summarized store personnel impacts in a clear way. First of all, they distinguish between subtle and apparent aspects. Subtle aspects of personal behavior such as smiles, good wishes, etc. contribute to positive feelings in one way. If sales personnel make extra effort and stretch beyond the necessary service level, positive in-store feelings may be generated in a second way.

Assortment

Assortment describes the breadth of the product alternatives offered by a firm. Each sales channel could offer its individual product portfolio. Thus, assortment impacts each sales channel. Li et al. (2007) found switchers to be more aware of alternatives. Therefore, it may hamper switching if a firm expands its product portfolio. A similar result was also revealed by Chen and Hitt (2002) in the online brokerage industry. They found switching to be negatively correlated to product range. It was also found that increased product alternatives increase overall satisfaction, which in turn boosts loyalty (e.g. Shankar et al. 2003). Verhoef et al. (2007) mentioned that an assortment including items like popular brands, newest types, etc. prove to be a relevant factor for store choice. Especially assortment is identified to be a strong factor for choosing the online channel. Litan and Rivlin (2001) found that wider product choice and customization is a major benefit of the Internet, which enhances consumer satisfaction. A main objective of consumers is to make better purchase choices (e.g., Keeney 1999). A wide assortment could help to fulfill that goal. Some differences between online and offline shoppers may arise at this point. Donthu and Garcia (1999) found that Internet shoppers tend to be more innovative and variety seekers. On the other hand Degeratu et al. (2000) mentioned that brands yield a higher impact online. Schoenbachler and Gordon (2002) finally noted that product availability influences the motivation to buy from a certain channel. If a product is not available online the competitor is just one click away. In the offline channel the issue may appear likewise. If the desired product is not available, consumers may migrate to the online channel.

Service

Service describes easy return policies or delivery on demand in case of the offline store. Return policies seem to be a major obstacle for both online and offline

stores. Hansen and Deutscher (1977) noted that ease of return is among the top ten relevant factors for physical retail stores. This result is similar to Lim and Dubinsky (2004) and Mattson (1982) who argued that on certain occasions, e.g. gift shopping, consumers are likely to purchase at department stores due to less stringent return policies than specialty stores.
In the online environment Schoenbachler and Gordon (2002) point out the fact that service is related to perceived risk. Better service will lower perceived risk, which in turn will decrease switching probabilities. A similar result comes from Anderson et al. (1993) who found that service quality influences switching intentions. Reibstein (2002) noted in that way that consumer service is important to make people stick to a certain web site. Consumers' return behavior is strongly influenced by the service at a particular site (Schoenbachler and Gordon 2002).

Assessment

An assessment prior to the purchase may be important for some product categories. Consumers may perceive too much risk in buying those products online because there is no opportunity to feel, touch and smell the merchandise (Alba et al. 1997).
Keeney (1999) found that consumers are concerned about quality issues when purchasing online. It is, for example, not possible to test-drive a car or to feel the structure of clothes online. Such products provoke high consumer costs if purchasing online and therefore prices have to be lower online (Chun and Kim 2005).
Other consumers feel some need for sensory evaluation. They want to self-affirm their expertise, which gives them also confidence in their choice. This type of consumer wants to squeeze an orange to assess its maturity or test-drive a car to check its handling. Thus, for some consumers the only option to purchase certain products remains the offline channel (Balasubramanian et al. 2005, Correll 1992, Brucks 1985).

Quality

Quality should evaluate the impact of product quality on store choice. It may turn out that for certain products consumers trust only one specific supplier. Alba et al. (1997) noted already that price may play a minor role when quality attributes become important. It seems to be a crucial attribute for offline shoppers. High quality is demanded by these consumers at department as well as grocery stores (e.g., Hansen and Deutscher 1977, Lim and Dubinsky 2004).

For gift-shopping or if consumers want to judge the quality by themselves, quality plays a bigger role. Under such circumstances consumers also tend to utilize the offline channel for their purchase (e.g., Balasubramanian et al. 2005, Mattson 1982). Thus, the task of buying a certain product may be influenced by the quality a particular store offers (e.g., van Kenhove et al. 1999).

Online consumers are exposed to purchase risk because it is difficult to judge the quality prior to the purchase. Therefore, good quality may be mandatory for online retailers (e.g., Verhoef et al. 2007). For this reason some authors argue for higher prices in the online channel (e.g., Chun and Kim 2005). However, by activities which provide arousal and pleasure the influence of quality could be reduced (e.g., Donovan et al. 1994).

Since quality attributes are hard to observe in the online channel, Internet shoppers tend to be more brand conscious than traditional shoppers (e.g., Donthu and Garcia 1999). This argument is supported by Schoenbachler and Gordon (2002) who found that higher familiarity with a certain brand could lower perceived risk. Keeney (1999) found that one fundamental goal of shopping is to maximize product quality. In that vein Li et al. (2007) and Park and Kim (2006) found that the awareness of alternatives and the quality of alternatives are major indicators of switching behavior. Thus, the quality of alternatives may be utilized to predict switching (e.g., Chen and Hitt 2002).

An interdependency between the online and the offline shop of the same retailer was also reported. Kim and Park (2005) point out that quality perceptions towards the offline store are transferred to the online store of the same retailer. Thus, trust might be transferred between shops of the same retailer (e.g., Balabanis and Reynolds 2001, Steinfield et al. 2002).

Security/Safety

Security of payments may be relevant for choosing the offline channel instead of the online channel. Thus, payment issues may turn out to be a major obstacle for online businesses. Consumers appear to be concerned about online payment security. Thus, a firm should assure a reliable and secure system for payment issues, which minimizes misuse of, e.g. credit card information (e.g., Keeney 1999). They further found safety to be one of the fundamental objectives consumers pursue when shopping online. Such a secure system should be communicated to consumers, because a positive relationship between information and security perception was found by Park and Kim (2006). Therefore, security may prove a competitive advantage for physical retail stores since shopping risk is lowest in the offline channel (e.g., Gehrt and Yan 2004).

Consumers in the online environment tend to seek secure environments. Thus, a key success factor for online businesses may be to enhance security on a web site. A more secure purchase process would lower perceived risk (e.g., Schoenbachler and Gordon 2002). Consumers' attitude towards perceived risk and the observed benefits from purchasing online determine their shopping behavior (e.g., Soopramanien and Robertson 2007).

Thus, security may be also an indicator to distinguish between Internet shoppers and shoppers in traditional stores. Donthu and Garcia (1999) found the former to be less risk averse than the latter.

Bakos (1998) finally noted that new types of intermediaries may emerge to fulfill payment issues.

Availability

Availability, i.e. the product can immediately be taken home, is an important factor of traditional retail stores (e.g., Lim and Dubinsky 2004).

Consumers strive for maximal product availability. Thus, their purchase decision appears to be strongly influenced by availability (e.g., Keeney 1999). Schoenbachler and Gordon (2002) also found that product availability influences the motivation to buy from a certain channel. Therefore, a firm holds the option to create positive in-store experiences for consumers by increasing availability of products

offered. Positive experiences afterwards result in, e.g. more money spent (e.g., Bäckström and Johansson 2006). If a desired product is not available, consumers become dissatisfied and may immediately switch to an alternative channel or firm (e.g., Wang and Head 2007).
For certain shopping occasions availability becomes most crucial. Gift shoppers rate availability highest priority (e.g., Gehrt and Yan 2004). Thus, immediate availability turns out to be indeed a decisive parameter in consumer's choice of the sale channel (e.g., Gehrt and Yan 2004, van Kenhove et al. 1999).
For certain product categories delivery is also important for consumers. If it is hard for consumers to carry products home (e.g. furniture, fridges, etc.), delivery becomes relevant like in the online channel (e.g., Chircu and Mahajan 2006, Lim and Dubinsky 2004).

Privacy

Privacy may be a distinctive factor. The offline channel may give consumers a sense of privacy regarding the protection of their financial information (Flavián et al. 2006a). On the other hand if anonymity is of concern, the online channel may be first choice. In any case, privacy is a major factor influencing online purchasing behavior (Lim and Dubinsky 2004, Zhang and Li 2006, Verhoef et al. 2007).
Keeney (1999) found privacy to be a fundamental goal for consumers undertaking online transactions. Thus, firms should take efforts to maximize privacy.
Consumers still are concerned about privacy issues in the online world. Strategies to resolve those doubts may turn out to be beneficial to a firm (Park and Kim 2006).

7.1.3 Communication Policy

Communication policy deals with information, advertisements and entertainment.

Information

The corresponding online counterpart to counseling might be information providing. The Internet allows consumers to gather information in a convenient and efficient way. Thus, current information is vital for online shops (Bakos 1997).

Shankar et al. (2003) noted the positive effect of information satisfaction on loyalty. Thus, they suggest making information retrieval as easy as possible. A current web site should also provide appropriate information. Further, they mentioned that additional information like local weather, maps, etc. could advance a web site and thus increase loyalty.

A similar result stems from Park and Kim (2006), who also revealed the positive effect of information quality on shopping behavior. They even found that information satisfaction could increase security perceptions.

Bridges and Florsheim (2008) finally mentioned that every online text should offer value by including the maximum possible information.

For some occasions or product categories, representation proved to be the most important factor influencing buying decisions, rather than on-time delivery or price (Reibstein 2002). They argued further that more information and higher information quality may lead to better purchasing decisions, which in turn raise consumers' satisfaction.

Atmosphere in the Store

The atmosphere in a store typically influences the purchase behavior of consumers. Balasubramanian et al. (2005) point out the quest for experimental impact. Donovan et al. (1994) found that the emotional state of an individual shopper within a store predicts actual shopping behavior very well. Firms should increase pleasure induced by the store environment to keep consumers in the store and furthermore persuade them to spend more money than initially intended. They even argue that pleasure and arousal contribute to time and money which is spent extra and unplanned, independent of other store attributes like perceived quality, variety and value for money. In their case study, Bäckström and Johansson (2006) revealed aspects more important for younger consumers. Their results indicate that products which are targeted at younger individuals should be offered in trendy and hip store environments. A store layout which allows consumers to easily find their desired products will also result in positive consumer experiences and positive experiences may increase loyalty. If the store appears illogically ordered to consumers, negative feelings may be provoked (e.g., Bäckström and Johansson 2006). Thus, store atmosphere like certain lights, scents and colors could result in positive or negative experience. If all ingredients compose a coherent picture, positive feelings may arise (e.g., Bäckström and Johansson 2006). Therefore, store atmosphere may turn out to be a competitive advantage for a firm, which could be used to differentiate besides the price. Gehrt and Yan (2004) found that online shoppers may be less sensitive to atmospheric influences than offline shoppers. This outcome seems natural since online shops could hardly touch sensory attributes like scents and lights.

Brand of Physical Retail Store or Onlineshop

The familiarity with a certain retailer could lower perceived risk and therefore alter purchasing behavior (Schoenbachler and Gordon 2002).

On the one hand it was argued that Internet shoppers are more brand conscious since they feel a distance (Donthu and Garcia 1999). On the other hand Gehrt and Yan (2004) found that online shoppers tend to be more adventurous and even willing to try shops with an unfamiliar face.

This difference may be due to the product category. Digital information goods or those products which hold similar properties may be less critical to order from unfamiliar shops. In contrast, credence products consumers may demand a trustworthy environment. In such cases familiar shops might be the only purchasing option.

Interactivity/Selection Support

Childers et al. (2001) already stressed the importance of enjoyment and entertainment on revisiting intentions. Web sites should provide such tools to attract consumers. The higher the perceived interaction of a consumer, the higher will be his satisfaction. Higher interactivity should also lead to higher perceived control, which in turn enhances shopping experience and therefore raises satisfaction

(Marmorstein, Howard et al. 1992, Alba et al. 1997). Wang and Head (2007) mentioned also the interrelation of perceived interaction and satisfaction.
Another quest remaining is that consumers should solve their problems utilizing aids from the web site. Such solution aids may increase consumer's loyalty and furthermore consumers tend to exhibit positive word-of-mouth (Kumar and Ruan 2006). Therefore, they argue that consumers should be given the option of manifold contact chances. A higher frequency of web-based contacts may return in a higher likelihood of multichannel shopping and even serve as a good indicator for loyalty (Kumar and Ruan 2006). The arguments of Häubl and Trifts, Valerie (2000) run in a similar direction. They found that decision aids may result in better purchase decisions which also increase satisfaction.

Usability

Usability may serve as the corresponding online counterpart to in-store atmosphere. There exists a positive effect of ease of use on loyalty (e.g., Shankar et al. 2003, Chen and Hitt 2002). Usability could increase trust in a web site and additionally increase satisfaction (e.g., Flavián et al. 2006a). Park and Kim (2006) found a positive relation between satisfaction and user interface quality. Lohse and Spiller (1998) mentioned that usability still is an obstacle to online shopping. Some consumers noted difficulties in finding things. In the same vein Shankar et al. (2003) argued that firms should offer access to information as easily as possible by providing intelligent search and appropriate information. They revealed a positive relationship of ease of use of obtaining information and loyalty. With those information tools the online medium could be utilized to reinforce loyalty (e.g., Shankar et al. 2003).
If a web site is used very often and consumers become familiar with the site, the switching propensity declines accordingly. There seems to be a reverse effect of usability on switching (e.g., Chen and Hitt 2002). Chen and Hitt (2002) also demonstrated the negative effect of minimized usability on the likelihood of switching.

Another interesting effect with highly usable web sites is that consumers could run into “flow”, i.e. they lose track of time and become exceptionally involved. This may result in higher sales (e.g., Novak et al. 2000).
Thus, firms should develop web sites according to requirements like high speed performance, offer easy ways to locate relevant information, reduce the number of navigation levels, etc. to enhance usability (e.g., Bridges and Florsheim 2008). Childers et al. (2001) also mentioned flexible navigation and convenient information search as important factors for online shoppers. Affinity towards computers amplified by knowledge of Internet usage influences the propensity of online shopping. Non-shoppers typically regard the process of online shopping as too complicated (e.g., Soopramanien and Robertson 2007).
But not only performance and navigation are important parts of usability. Web site characteristics like eye appeal, ease of the purchase process and product layout might also affect the purchase behavior in the online channel (e.g., Schoenbachler and Gordon 2002).

7.1.4 Distribution Policy

Distribution policy is a major determinant of online shops. It deals with sales channels, ordering, logistics, transport and delivery.

Delivery Time

Delivery time in the online channel has its counterpart in availability in the physical retail stores. Fulfillment of delivery, i.e. the physical delivery of real world orders from the virtual world is still a problem to online retailers (e.g., Chun and Kim 2005). The unsolved problem gives rise to new types of intermediaries for delivery (e.g., Bakos 1998). Digital information goods are the big exception. This product category holds the advantage of instant delivery like in physical stores (e.g., Chun and Kim 2005).
Timely delivery is still a crucial factor for online retailers. Online shoppers seek on-time delivery (e.g., Schoenbachler and Gordon 2002, Lim and Dubinsky 2004, Gehrt and Yan 2004). Reibstein (2002) further noted that timely delivery is relevant for repeat purchase. Once consumers become discontent, it will be hard to

attract them back. Even more, most of the consumers tend to sort their online search by price in the first row, but delivery time in the second row. Thus, delivery time may increase sales without participating in damaging price wars.
Soopramanien and Robertson (2007) concluded that browsers, i.e. consumers who scan the Internet for bargains but undertake their purchase in traditional stores, are most of the time dissatisfied about delivery times. Thus, on-time delivery represents a large area of enhancements for firms, but also of discontent to consumers (e.g., Reibstein 2002). It seems clear that firms are well advised to take care on reliable delivery (e.g., Keeney 1999, Chircu and Mahajan 2006). All in all consumers regard delivery time as an integral part of the overall transaction costs (Liang and Huang 1998). Thus, discounts may attract consumers from the offline channel to the online channel despite the delivery time.

Delivery Options

This attribute should evaluate the impact of additional delivery options, like insurance and additional delivery points, on the channel choice. The point of delivery may be important. Most humans work throughout the day and thus delivery to their workplace might increase convenience since they do no longer have to pick up their delivery at the nearest post office.
Further, it is assumed that for certain products (e.g. jewelry) insurance may be an important factor for purchasing online.

Chapter 8

Simulation Model

Unfortunately the formulas of the model are no longer analytically tractable, hence we performed simulations in the remaining sections. From the simulation results we draw conclusions for managerial guidance. Simulations have been proven successfully in marketing science (e.g., Stremersch and Tellis 2002, p. 17). The simulation model consists of a Genetic Algorithm to evaluate a firm's optimal pricing behavior and the corresponding marketing activities, given a certain market environment represented by the second firm. In this work an Evolutionary Strategy (Bäck et al. 1992) is used to perform the optimization tasks. This approach is taken because the Evolutionary Strategy holds the power to elicit rational behavior when continuous values represent different strategies (Takadama et al. 2003). The parameter setting for the evolutionary strategy is the following

- parent population $\mu = 1000$
- mating pool for new generation $\lambda = 3000$
- mutation rate 40 %
- mutation range 0.5, i.e. to/from a value which is appointed to mutate half the standard deviation of all corresponding generation values will either be added or subtracted.
- crossover rate 15%

The algorithm is programmed in R (R Development Core Team 2008). The complete source code can be found in Chapter C in the appendix.
To fill in the theoretical model we utilize the survey results. The survey can also be found (in German) in the appendix in Chapter B. From the different price data, reservation prices and switching probabilities in terms of accepted price differences will be estimated. From the ranking of the different marketing activities the impact and the relevance of each marketing strategy can also be observed.

8.1 The Firm Side

A firm $j = \{1,2\}$ is described by a tuple $F_j = \{p_{B_j}, p_{O_j}, M_j\}$ which could be altered by the firm instantly. The relevant marketing actions for this model are described in detail in Chapter 7.
Since marketing activities are valued in the survey, the available offline activities of M_j consist of a set of the following 12 attributes: availability, brand of store, counseling by sales personnel, breadth of assortment, convenience (e.g., parking lots), service, clientele, quality of the products sold, security, privacy, and assessment. These attributes define the 12 sub-activities only relevant for the offline channel.
In contrast, the sub-activities of M_j only affecting the online channel consist of: delivery time, convenience, usability, delivery options, information, security, privacy, brand of web site, interactivity, return policy, breadth of assortment, and clientele. Thus, 13 attributes are available for each firm to enhance its online appearance.
One firm is modeled by genetic algorithms. A firm described with evolutionary strategies consists of μ (parent population) tuples of different pricing and marketing strategies. A specific tuple F_k (see Equation 8.1) consists of a certain online price p_O, an offline price p_B and expenditures for marketing in the online channel and in the offline channel.

$$F_k = \{p_{B_j}, p_{O_j}, M_j\} \qquad \forall j = 1,2 \tag{8.1}$$

Such a tuple represents one specific occurrence of a firm in the genetic algorithm. Note that for each firm j different tuples exist.
The prices are normalized between zero and one, i.e. we assume all available prices in the market are within $p^* \in [0,1]$ and therefore $p_O, p_B \in \{p^*\}$. A further restriction applies to the marketing expenses. These marketing parameters are bounded by some budget constraint. The sum of all expenses must not exceed one (see Equation 8.2). Let the financial effort for one particular marketing activity i be m and j denote the firm.

$$M_j = \{m_i\} \qquad \forall j = 1,2 \tag{8.2}$$

$$\sum_{i=1}^{25} m_i = 1 \leq 1 \tag{8.3}$$

These values could be interpreted as percentage investments in each distinctive field of marketing given a certain budget. As already mentioned, these values could alter the competitive landscape between firms and sales channels by modifying consumers' switching probabilities. The goal of the firm is to maximize its profit (see Equation 6.26).

8.2 The Consumer Side

Consumers are determined by the whole structure of reservation prices and different switching probabilities, i.e. a single consumer is described by the tuple

$$\begin{aligned} C_i \quad = \quad & \{R_B, R_O, S_{IBO_1}, S_{IOB_1}, S_{FBB_1}, S_{FBO_1}, \\ & S_{FOO_1}, S_{FOB_1}, S_{IBO_2}, S_{IOB_2}, S_{FBB_2}, S_{FBO_2}, \\ & S_{FOO_2}, S_{FOB_2}\} \end{aligned} \tag{8.4}$$

Equation 8.4 displays the whole structure of distributions which describe the consumer market. Note that S_{FOO_1} and S_{FBB_1} have not been observed and were set equal to one for the simulation, i.e. no switching from an offline channel towards the alternative offline channel, and from an online channel towards the competitor's online channel occurs. This is one weakness and will be discussed in the limitations (see Chapter 14). The different probabilities prescribe the consumers and could be influenced by a firm's marketing activities M_j. More accurately, the reservation prices R_B and R_O remain fixed and resistant to marketing. All other probabilities could be altered by the firm. Thus, consumers' attitude towards a certain firm or sales channel might be modified by influencing a certain probability.

An apparent result says that if all probabilities are symmetric, no competitive advantage is in the market, and the online and offline prices of both firms are equal, the market will be shared equally between both firms. This result is stable as long as both firms keep their marketing activities the same.

Since the model should utilize real data, from the survey distributions for not-accepted price differences as well as the reservation prices are obtained. The distribution of the reservation prices could be estimated from the confessed purchasing prices, i.e. the purchasing prices serve as proxy for the reservation price of an individual consumer. With the use of maximum likelihood the parameters of the probability functions could be estimated.

8.3 Scenarios

To gain some insight into the competitive environment of each product, simulations with the following situations are performed. The scenarios present extreme cases of certain market situations, thus firm 1's reactions and pricing strategies may also become somehow extreme. Firm 2 is the scenario lead, i.e. firm 2 sets up certain marketing and pricing strategies and firm 1 should deal with them. An optimal counter strategy for firm 2's behavior should be found.

	p_{B_2}	p_{O_2}	ξ_{B_2}	ξ_{O_2}
Scenario 1	0.10001	$\tilde{p_{O_2}}$	1	0
Scenario 2	$\tilde{p_{B_2}}$	0.10001	1	0
Scenario 3	0.10001	$\tilde{p_{O_2}}$	0	1
Scenario 4	$\tilde{p_{B_2}}$	0.10001	0	1

Table 8.1: Simulation Scenarios

Table 8.1 gives an overview of all applied scenarios. The column p_{B_2} gives the applied offline price of firm 2. A price of $= 0.10001$ indicates that firm 2 operates almost at its unit costs, which are held constant at 0.1 throughout all simulations. Therefore, in such scenarios firm 2 prices highly competitively in that particular channel. The p_{O_2} column represents the same for the online channel of firm 2. The tilde-prices are calculated by firm 2 optimizing just on the corresponding demand shape.

$$\tilde{p_{B_2}} = \arg\max_{p_{B_2} \in 0,1} \widehat{b_B}\,(1 - R_B(p_{B_2}))\,(p_{B_2} - c_{B_2}) \quad (8.5)$$

$$\tilde{p_{O_2}} = \arg\max_{p_{O_2} \in 0,1} \widehat{b_O}\,(1 - R_O(p_{O_2}))\,(p_{O_2} - c_{O_2}) \quad (8.6)$$

Equations 8.5 and 8.6 show the evaluation of the tilde-prices. These prices should also prove competitive since monopolistic prices usually are located just above the optimal price for a duopoly.

ξ_{B_2} gives the marketing efficiency of firm 2 for the offline channel. A value of one shows maximally efficient marketing investments, i.e. the firm's investments into the marketing activities equal consumers demand. Zero indicates no marketing investments in that channel at all. The parameter ξ_{O_2} represents the same as ξ_{B_2}, just for the online channel. All these four scenarios run through the genetic algorithm to find the optimal pricing policy of firm 1.

Note that these scenarios are very extreme presentations of market situations. These extreme forms should underline special outcome and point at important issues more obviously.

8.4 The Beta Distribution

For each individual probability a standard Beta distribution is assumed. We chose the standard Beta distribution because it is a very flexibly one. With only two parameters a broad range of density shapes could be reproduced. Further the standard Beta distribution is defined only between zero and one.

$$\mathbf{B}(\alpha,\beta) = \int_0^1 t^{\alpha-1}\,(1-t)^{\beta-1}\,\mathrm{d}t \tag{8.7}$$

$$f(x) = \frac{x^{p-1}\,(1-x)^{q-1}}{\mathbf{B}(p,q)} \qquad 0 \leq x \leq 1; p,q > 0 \tag{8.8}$$

Equation 8.7 shows the Beta function itself, and Equation 8.8 gives the density function of the standard Beta distribution. p and q represent the parameters of the Beta distributions. The Beta distribution further has the following properties

$$\mathbf{E}[X] = \frac{p}{p+q} \tag{8.9}$$

$$var(X) = \frac{pq}{(p+q+1)\,(p+q)^2} \tag{8.10}$$

8.5 Estimating Beta Distributions with Maximum Likelihood

From the price data of the survey, the corresponding reservation prices and switching probabilities with respect to pricing will be estimated. To achieve that, the Maximum-Likelihood method for univariate distributions was conducted.

Since the Beta distribution provides no closed form, maximization of the log-likelihood function is done by an numerical optimization algorithm. The Nelder-Mead (Nelder and Mead 1965) algorithm is utilized. This algorithm refers only to function values, is robust but turns out to be relatively slow. The advantage of this algorithm is suitability for non-differentable functions like the Beta distribution.

Since in this case the Beta distribution was restricted to be within zero and one, a set of parameters is already defined. Therefore, the method of moments estimates for the parameters p and q is

$$p = \bar{x}\left(\frac{\bar{x}\,(1-\bar{x})}{\sigma^2} - 1\right) \tag{8.11}$$

$$p = (1-\bar{x})\left(\frac{\bar{x}\,(1-\bar{x})}{\sigma^2} - 1\right) \tag{8.12}$$

Equation 8.11 and 8.12 serve as initial values, or posterior parameters, for the optimization process of the likelihood functions. In both equations $\bar{x}$ represents the sample mean and σ^2 is the corresponding variance.
The maximum likelihood functions for the Beta distribution are

$$\psi(\hat{p}) - \psi(\hat{p}+\hat{q}) = \frac{1}{n}\sum_{i=1}^{n}\log(Y_i) \tag{8.13}$$

$$\psi(\hat{q}) - \psi(\hat{p}+\hat{q}) = \frac{1}{n}\sum_{i=1}^{n}\log(1-Y_i) \tag{8.14}$$

where ψ represents the digamma function

$$\psi(x) = \frac{\Gamma'(x)}{\Gamma(x)} \tag{8.15}$$

Chapter 9

Methodology

To give answers to the questions of what price to charge in each individual channel, what the influence of a certain product category is and how to optimally set additional marketing activities, a survey was conducted. A survey seems to be appropriate to get information on reservation prices (Völckner 2006). From the survey, distributions for the theoretical model were deduced. This model will be exposed to certain market situations to capture the optimal behavior of a firm doing business in such an environment. Since the distributions are expected to be different from unimodal, a genetic algorithm will be applied to calculate the optimal strategy of a firm.

9.1 Survey

In the survey respondents were asked to give answers regarding books, digital cameras and clothes. Books, clothes and digital cameras represent "centers" of three distinctive clusters. Books could be attributed to commodity-like goods, clothes to look-and-feel goods and digital cameras to quasi-commodity goods (Girard et al. 2003, Choi et al. 2006, de Figueiredo 2000). Thus, marketing actions desired for each product should show maximal differences. Participants were further requested to give information on the price they actually paid, the maximum price they would pay in the alternative channel and to rank different marketing strategies according to their demands. That is to say, first consumers were asked

to name the price the usually pay for the products and give their favorite shopping channel, e.g. the online channel. Afterwards participants were requested to give the maximum price they would be willing to pay in the alternative channel, e.g. the offline channel. In the end consumers were demanded to rank marketing strategies they regard for each channel independently.
From that information, reservation prices and switching probabilities could be estimated utilizing maximum likelihood. Thus, all price statements of a typical purchase in one channel where taken to estimate the distribution of reservation prices in that channel. The switching probabilities were calculated by taking the price differences from the preferred channel towards the alternative channel. If the participant denoted the online channel as his favorite channel for purchasing digital cameras he may demand a discount for purchasing in the offline channel. This discount forms the basis for the switching probabilities from the online channel towards the offline channel for each firm. The same procedure applies in the reverse direction, i.e. switching from offline to online. As mentioned before, switching within the same channel, i.e. from offline to offline or from online to online was not recorded. This may be an extension for further research. Finally the competitive advantage of a channel was calculated by the proportion of online to offline consumers. If for example three consumers preferred the online channel for purchasing digital cameras and only one favored the offline channel, the resulting pecuniary advantage of the online channel will be $\frac{1}{3}$. This is to say that the online channel could be ceteris paribus one third more expensive than the offline channel to make the online consumers indifferent between both channels. In other words, if both channels are priced equally the online channel appears one third cheaper than the offline channel to online consumers.

9.2 Sample Constitution

The sample has the following structure. In total 1068 participants took part in the survey. For books 307 rankings, for clothes 438 and for digital cameras 435 rankings were observed.

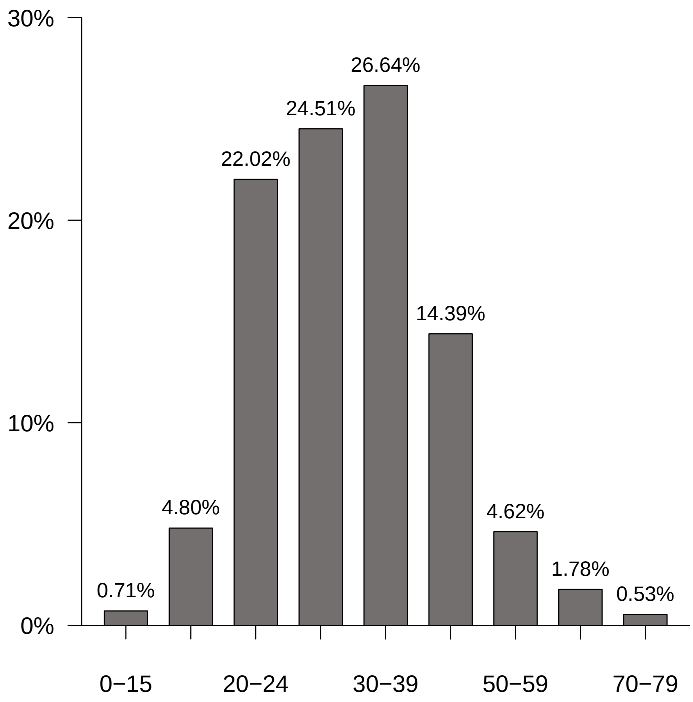

Figure 9.1: Age Structure

The age structure (see Figure 9.1) consists of 4.80 % 15-19, 22.02 % 20-24, 24.52 % 25-29, 26.64 % 30-39, 14.39 % 40-49, 4.62 % 50-59, 1.78 % 60-69 and 0.53 % 70-79 year old consumers. Gender figures show 27.05 % females and 72.95 % males. Education figures (see Figure 9.2) display 3.37 % who finished compulsory school, 15.28 % who are in apprenticeship, 11.01 % who passed a professional school, 43.87 % with a graduation diploma and 26.47 % who obtained a university diploma.

Detailed results for each individual product can be found in Chapters 10, 11 and 12. In those chapters the optimal marketing strategies for each product will be presented. From these results, as well as from the price statements of the survey participants, the corresponding probability shapes of the model will be estimated. Basic simulations cover price elasticities and consumer drift dynamics given certain prices of firm 1. Finally, the optimal pricing strategy for firm 1 given special market environments will be calculated.

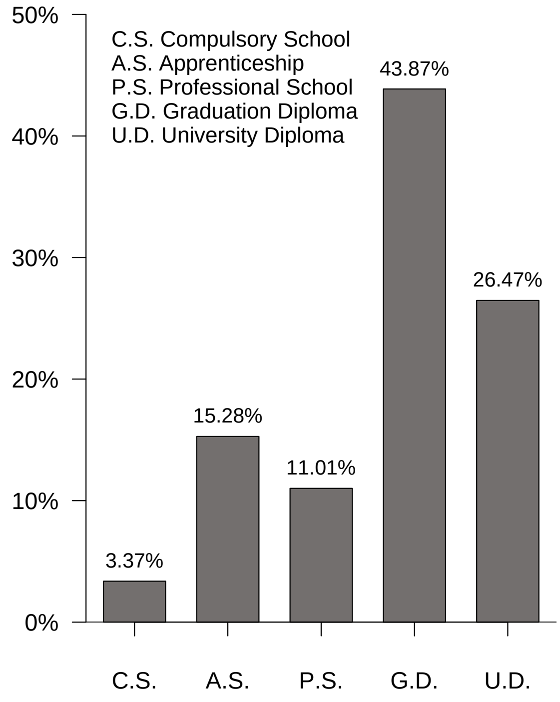

Figure 9.2: Educational Structure

Chapter 10

Results Books

Books are usually thought to be nearly digital information goods. With the knowledge of the ISBN number a consumer knows what he gets, irrespective of the store. Further, the attributes of a certain book are easy to capture. There are no such subtle technical differences as with digital cameras and it may not be necessary for consumers to feel or touch a book to evaluate the quality. The description of a book is textual and therefore digitizable. All relevant information for a purchase can be found online. Even more, since a book is identified by its ISBN number, price comparison could easily take place. Competition may be reduced to pricing in such a setting since product features do not contain competitively valuable differences.

For books we received 304 pairs of prices at which consumers actually bought, combined with the corresponding reference price for purchasing in the alternative channel. The number of consumers who prefer the offline channel amounts to 162, whereas the number of consumers in favor of the online channel is 142. The difference between both different consumer cohorts seems to be negligible, i.e. a large number of consumers still use traditional stores to purchase books. This finding is quite interesting given the nature of the product.

The price information is utilized to estimate different Beta distributed densities, which afterwards will be included in the theoretical model.

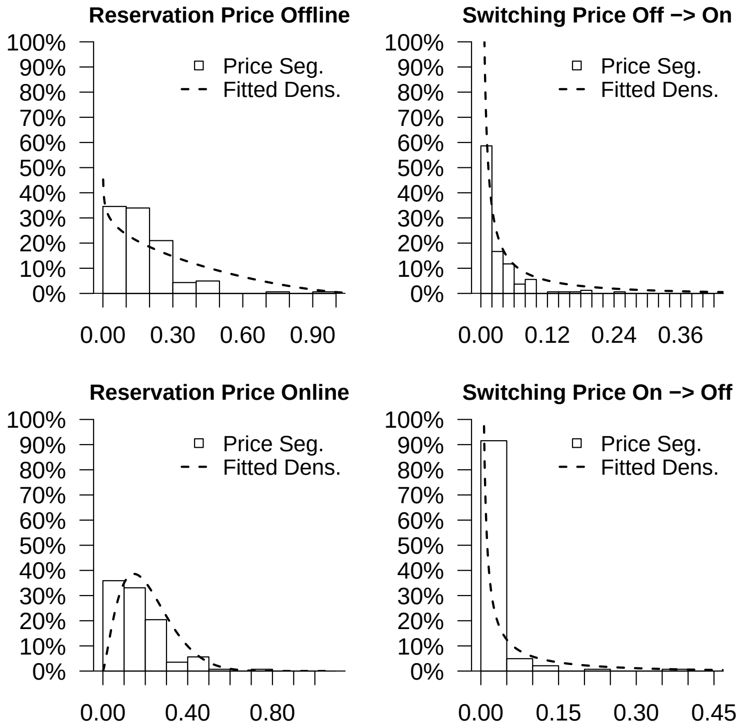

Figure 10.1: Frequency of Relative Price Statements

Figure 10.1 displays the frequency of price statements relative to the overall maximum of 200 paid at a usual purchasing occasion (Figure Reservation Price Offline and Reservation Price Online). The other two graphs show the markup consumers require for shopping in the alternative channel. These markups are also normalized between zero and one relative to 200. Therefore, the whole price range of purchased books and the equivalent markups are between zero and one. The red lines in each figure depict the density function of the corresponding estimated Beta distribution for these prices. One can see that the highest price purchase was conducted through the offline channel. Another important issue is that offline consumers seem to have lower reservation prices, i.e. at a price of 0.5 the firm may capture already 14.9 % of the total available offline consumers but only 10.5 % of the total online consumer base. The interesting thing, though, is that both switching probabilities are almost similar, i.e. consumers preferring the offline channel demand similar pecuniary compensation for switching to the online channel as consumers favoring the online channel and considering the offline channel. Fur-

ther different price elasticities can be observed. In the lowest price segment, i.e. books from $7-10$ €, a consumer surplus of roughly 40 % could be achieved in the offline channel versus the online channel. In a price range from $10-50$ € the picture is almost reverted. Around 25 % consumer surplus could be reached through the online channel. For books and price above 50 €, the offline channel is again the favorable channel for firms, since 43.3 % of offline consumers could be achieved while in the online channel a mere of 27.3 % consumers are attainable. Thus, the offline channel seems to be the more important sales channel for books because consumers show higher reservation prices in this channel and therefore consumer rents could be improved. Pricing is indeed an important issue for books. This can be seen with the switching probabilities in Figure 10.1. One outcome is that offline consumers seem to be more state-dependent, i.e. their propensity to switch is lower than for online consumers.
The parameter values for each Beta distribution are given in Table 10.1. Note that

	Shape Parameter p	q	Distribution at the Model
Offline Reservation Price	0.88671820	2.53622180	R_B
Online Reservation Price	2.35212100	9.79252900	R_O
Offline → Online Switching	0.08644153	3.54315486	S_{IBO}, S_{FBO}
Online → Offline Switching	0.07490756	3.58202388	S_{IOB}, S_{FOB}

Table 10.1: Parameters for the Beta Distributions

due to shape parameters lower than one, the density function results in some kind of U-shape (not unimodal), which makes it difficult for optimization algorithms like Newton and Nelder-Mead to find the optimum. Therefore, genetic algorithms seem again to be a good choice.
One problem remaining is switching within the same channel (S_{FOO} and S_{FBB}). This switching behavior was not part of the survey, since it is definitly hard for participants to give price markups for the alternative channel. It seems to be even harder to judge price markups for alternative firms within the same channel. One could hypothesize about different switching probabilities. The switching probability from one offline channel to the other should be very low compared to the switching probability from one online channel to the other. This assump-

tion seems to be natural, since in the virtual environment the competitor is just one click away, whereas in the real world visiting an alternative firm is associated with an increased effort in time for example. But this question is left for further research.

10.1 Marketing Strategies

Participants were asked to rank their reasons for choosing a certain channel. From these ratings the optimal marketing policy apart from pricing should be conducted. For each attribute its rankings were summarized by each order. These rank sums afterwards were multiplied with the "inverse" order number, i.e. the sum of all first rankings of each product is multiplied with the number of attributes in that sales channel, the second rank was multiplied with the number of attributes less one, and so on and so forth. Let $r_{a_c} \quad r \in [1,0]$ be the rank a consumer c assigns to a certain attribute a for the offline channel.
The total rank now becomes

$$\bar{r_a} = \sum r_{a_i} \tag{10.1}$$

$$r_a^* = \frac{\bar{r_a}}{\sum \bar{r_a}} \tag{10.2}$$

Equation 10.2 gives the optimal investments for each attribute. Index i denotes all rankings given by the participants. Value $\bar{r_a}$ denotes the sum of all weights a certain activity receives. Thus, r_a^* represents the relative importance of the marketing attribute a. The corresponding optimal efforts for each channel I_B and I_O could be deduced by just taking relevant attributes for each channel into account.
Results show a clear difference regarding the online and the offline channel. In a traditional store environment 153 consumers ranked availability and the option to take the book home immediately as the number one argument for purchasing. Interestingly, since books have some attributes like digital information goods, assessment is second-most ranked on first place. For 79 consumers the most important factor for choosing the offline channel was the chance to assess the book. In the online shop 163 consumers voted convenience to be the decisive factor for picking that environment. This is not surprising since ordering from home and

delivery is the unique selling proposition of online stores. Assortment and delivery time, with 48 and 40 votes respectively, were second most often number one ranked. So it seems that assortment may be one cause for the success of Amazon, since a traditional retail store could not usually afford to offer such a wide range of products. Delivery time may be the counter attribute to immediate entrainment in the offline channel. Fast delivery may be important to keep the uncertainty due to mismatching of payment with physical delivery at low levels.

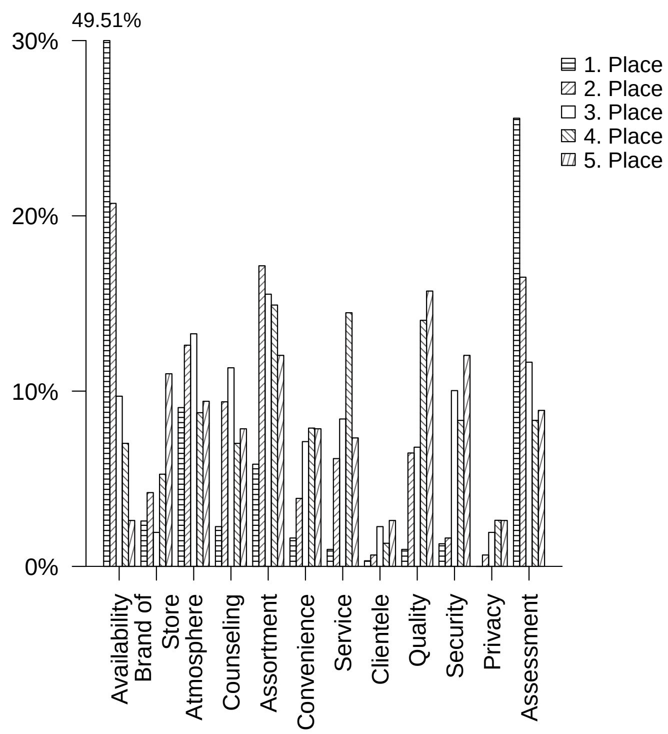

Figure 10.2: Importance of Marketing Attributes Offline

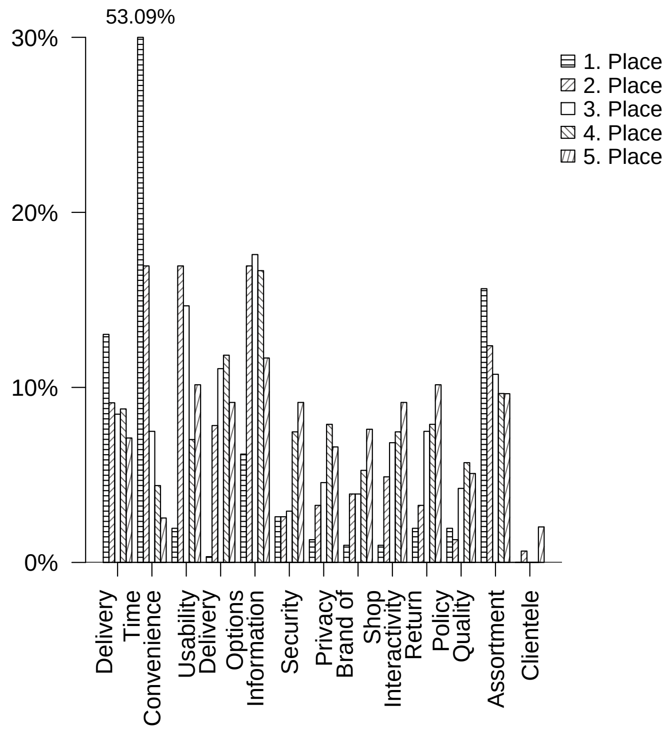

Figure 10.3: Importance of Marketing Attributes Online

Figure 10.2 and 10.3 depict the fractions of rankings for first place, i.e. most important attribute, up to fifth place. One can see that availability is indeed the most important factor. Surprisingly, assessment is second most important. Another interesting finding is that assortment as well as atmosphere are highly relevant attributes for consumers purchasing in traditional stores. For the online environment, besides convenience, the factors assortment, information and delivery time turn out to be highly important for consumers choosing the online channel.

Since assortment is ranked very highly in both sales channels, it may be an obstacle for the traditional store and an enabler for online shops since the latter could offer a deep range of products at low costs. Therefore, lack of assortment may turn consumers into online shoppers.

Information may be another important feature of online shops. During shopping consumers browse through offered books to search for something desirable. The final order is just one click away. Thus, providing extensive information may boost online sales (Wang and Head 2007, Park and Kim 2006).

But it could also be the reverse. The online channel may serve as information channel. Consumers inform themselves in the online environment and purchase offline afterwards (e.g., Reardon and McCorkle 2002).

Offline		Online	
Availability	0.13180253	Delivery Time	0.05118746
Brand of Store	0.01779564	Convenience	0.12877565
Atmosphere	0.05476464	Usability	0.048997
Counseling	0.0347876	Delivery Options	0.03170394
Assortment	0.06165327	Information	0.0650219
Convenience	0.02181401	Security	0.01740835
Service	0.02858783	Privacy	0.01740835
Clientele	0.00516648	Brand of Shop	0.01590961
Quality	0.02893226	Interactivity	0.02190454
Security	0.02227325	Return Policy	0.02248098
Privacy	0.00493685	Quality	0.01394973
Assessment	0.08748565	Assortment	0.06386903
		Clientele	0.00138344

Table 10.2: Optimal Marketing Investments

Table 10.2 gives the optimal spending efforts for each marketing attribute. The investments are normalized so that they add up to one, which is the maximum allowed marketing effort. If a firm behaves exactly like this, its marketing efficiency will be maximal in each channel. Optimal marketing moves the shape of the switching distributions in favor of the performing firm.

10.2 Elasticity

The demand function for books is given by a set of Beta distributions which all depend on prices and price differences. The elasticity is given by the first derivative of the demand function. To display an overview, we restrict our price elasticity measures on the offline price of firm 1 and perform two situations exemplarily. 10.4.

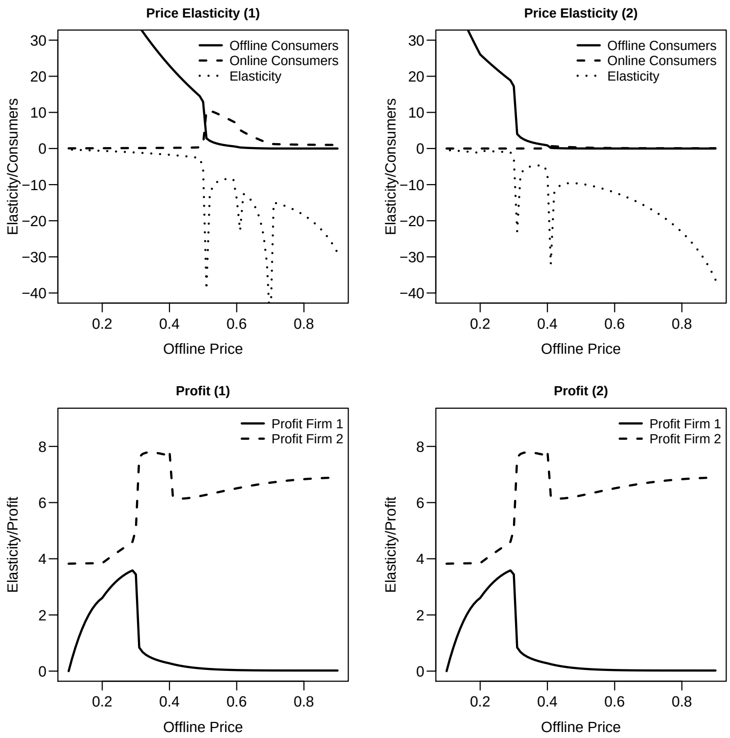

Figure 10.4: Price Elasticity versus the Offline Price of Firm 1

Figure 10.4 displays the dynamics of the price elasticity of firm 1's offline consumers with respect to firm 1's offline price and a consumer base of 100 in each channel without taking effects of marketing activities into account. The second row represents the dynamics of firm 1's overall profit. For detailed tables refer to the appendix (see Table A.1).

One can easily detect the other prices since the negative spikes in the elasticity curve of consumers indicate them. The first column of figures (*Price Elasticity (1)* and *Profit (1)*) displays prices of the following: The first spike relates to the fixed price in firm 1's online channel of 0.5. An immediate increase in the number of online consumers as well as a drop of almost the same amount in offline consumers emerge at that crossing point. The peak in elasticity stems from introducing the online channel as alternative channel since prices become equal. Interestingly, no additional profit could be made by setting online and offline prices equal. This result is due to the fact that both prices are well above the optimal prices. The second spike stems from firm 2's online channel which prices at 0.6.

Declining online consumers underline that issue. At the same price level a kink in the profit curve could be observed, which is due to falling online consumers. Since online and offline price of firm 1 and online price of firm 2 are at the same level, switching between these channels occur and the available consumers are somehow shared. The last peak relates to firm 2's offline price of 0.7. After this time the elasticity drops dramatically. If the offline price of firm 1 is increased any further, the dramatically decreasing elasticity is not surprising. All alternative channels become cheaper than the offline channel of firm 1. Therefore, consumers will react and move to one of the alternatives. Another important observation may be the increasing profit of firm 2 from the point where both offline channels offer equal prices. At the intersection of both profit lines, each offline channel prices equally. Further increasing firm 1's offline price will harm firm 1's profits.

Figures *Price Elasticity (2)* and *Profit (2)* of Figure 10.4 display a similar extract of the whole dynamics. In this case firm 2's online price is set to 0.2, which is clearly pointed out by firm 2's profit shape. Firm 1's profit shape is lower than in the former case. This is a clear sign of lower prices of firm 2. The first peak at 0.2 is due to firm 1's offline price exceeding firm 2's online price. The second harmful spike results from firm 1's offline price exceeding firm 2's offline price. From this level on, both prices of firm 1 rest above firm 2's prices. Interestingly, firm 2 loses profit as the offline price of firm 1 runs above firm 1's online price.

An important deduction may be that each crossing of prices in alternative channels decreases elasticity in the current channel. These results seem to be obvious. As soon as the price level of a certain channel reaches the price level of an alternative channel, consumers become aware of that alternative. A further increase of the price in the current channel will drive consumers more quickly towards the now cheaper alternative. Thus, price increases may result in larger effects on consumers in a certain channel.

10.3 Mean and Variance

The price structure of a certain market is not only determined by price levels and price elasticities but also by price variance. A short overview of the structure of the reservation prices may shed light on the book market. Table 10.3 displays

	Offline	Online	Both
Mean Reservation Prices	0.18861110	0.18968310	0.18911180
Variance of Reservation Prices	0.01754293	0.01506816	0.01633370
Mean Markup	0.02638889	0.02218310	0.02442434
Variance Markup	0.00181157	0.00225442	0.00201609

Table 10.3: Results Summary

variances of price statements of consumers. The variance in reservation prices of the offline channel is larger than the reservation prices for the online channel. However this finding is not statistically significant at a 5 % level. Similar results are obtained by investigating the demanded markup. Reservation price levels also give a similar picture. Both means are very similar and statistically indifferent at a 5 % level [1]. One interesting observation remains: means and variances could be misleading. If we compare the current results with those from Figure 10.1, large differences become evident. This may indicate that individual reservation prices are vital for applying optimal pricing strategies.

10.4 Consumer Drift Dynamics

Consumers drift from one channel to the other, apart from different prices, also due to different marketing and most important due to individual preferences. To incorporate those preferences various offsets are calculated. The basic competitive advantage of a channel emerges from the survey. Different numbers of consumers preferring a certain channel form the foundations of the offsets. Let the number of participants of the survey which favor traditional store environments be denoted by b_B^S and the number of those who prefer the Internet by b_O^S. The pecuniary offset for each channel is calculated by

$$OF_{.BO} = 1 - \left(1 - \frac{1}{\max\left(b_B^S, b_O^S\right)}\right) b_B^S \tag{10.3}$$

[1]Insignificant test results for Ansari-Bradley test for similar variance and Mann-Whitney test for similar means.

$$OF_{.OB} \quad = \quad 1 - \left(1 - \frac{1}{\max\left(b_B^S, b_O^S\right)} \right) b_O^S \tag{10.4}$$

Equation 10.3 gives the pecuniary offset of the offline channel. Values below zero indicate competitive advantages for the offline channel, i.e. for a value of -0.1 the online channel has to offer prices 0.1 below the prices in the offline channel to avoid switching. At such a price consumers become indifferent between both channels and therefore switching falls. For values of $OF_{.BO}$ above zero, the competitive advantages fall to the online channel. In this case prices in the traditional environment have to undercut online prices by the value of $OF_{.BO}$ to make consumers indifferent between both channels. Equation 10.4 gives the competitive offset for the online channel, which is also related to the number of consumers preferring a certain channel above the other.

For books there emerges a small competitive advantage for the offline channel, i.e. a slightly larger fraction of consumers still prefer the offline channel. The pecuniary advantage amounts to 0.1234568. Therefore, the online channel should offer a price 0.1234568 below the offline price to prevent consumers from switching to the offline channel.

OF_{IBO}	0
OF_{IOB}	0.1234568
OF_{FBO}	0
OF_{FBB}	-
OF_{FOB}	0.1234568
OF_{FOO}	-

Table 10.4: Initial Offset Values

Table 10.4 gives all initial offset values for the book environment. All offsets corresponding to consumers drifting from the online to the offline store exhibit positive numbers, indicating competitive advantages for the related offline channels.

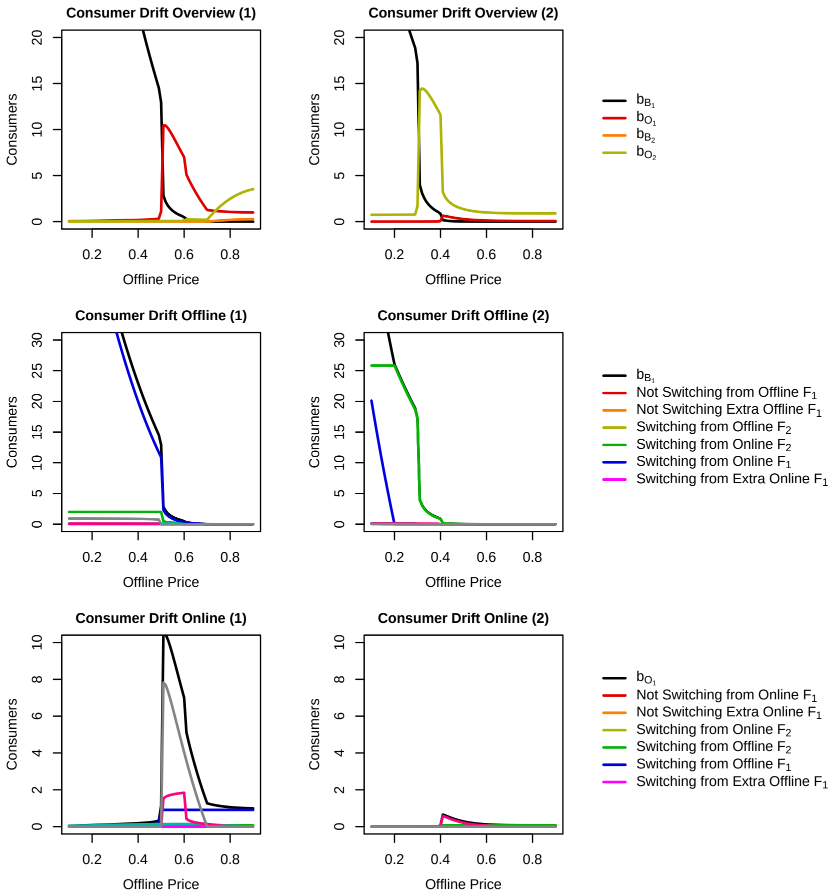

Figure 10.5: Elasticity

Figure 10.5 displays the composition of consumers at both channels of firm 1. Again, two scenarios (see Paragraph 10.2) were utilized and detailed tables can be found in the appendix A.1. The figures in the first column, denoted by the suffix *(1)*, result from firm 1's online price of 0.5, firm 2's offline price of 0.7 and its online price of 0.6. The offline price of firm 1 varies. The first figure shows an overview of the total consumers for each firm. As we might expect, the total consumers of the offline channel b_{B_1} drop as soon as the price of the online channel is reached. But as the offline consumers decline, the number of total online consumers b_{O_1} increases by the same amount. The number of extra offline consumers attracted due to lower prices reaches zero as soon as firm 2's offline price is met. A drop in the total online consumers b_{O_1} is also visible as the offline price tops firm 2's online price. This occurs since firm 1's offline consumers do not switch only to its online channel but also to firm 2's online channel.

The second figure *Consumer Drift Offline (1)*, which breaks the total offline consumers down to the basic parts and the last figure in the column (*Consumer Drift Online (1)*), which shows the same for online consumers, should be considered together. A loss in the offline channel should result in a gain in the online channel as long as both prices are below the competitor's prices. Again, the total consumer base b_{B_1} of firm 1 drops as the offline price reaches its online price. This drop is related to an increase of almost the same amount in total online consumers b_{O_1}. So, consumers migrate from the offline channel to the online channel of firm 1.

The non-switching extra consumers of the offline channel show a similar behavior. Again, growing extra offline consumers migrating from the offline channel towards the online channel can be observed in the last figure.

Naturally reversed appears the development of the non-switching extra consumers of online consumers. As soon as the offline price meets the online price, no online consumer migrates from the online channel of firm 1 away to any alternative channel. The online channel of firm 1 starts to be the cheapest one from this point on. Extra consumers of the offline channel decrease gradually till the offline price of firm 1 meets the corresponding price of firm 2. Conversely, extra online consumers of firm 1 do not decrease and remain stable. That outcome is obvious since firm 1's online price remains lower than firm 2's online price and therefore firm 1 could earn some extra consumers in the online channel.

In the price range where firm 1's offline price lies between 0.5 and 0.6, consumers switching from both competitor's channels towards the offline channel of firm 1 are negligible since even firm 1's prices are relatively high and therefore even fewer consumers are attracted by firm 2's pricing. Consumers migrating from firm 1's offline channel towards firm 1's online channel can be observed in the last figure. The basic offline consumers and the extra consumers offline start to migrate as the offline price hits the online price. The increasing offline price has the effect that extra consumers decline further and retain switching towards firm 1's online channel till the benefit of lower prices offline is lost because firm 1's offline price meets that of firm 2.

The basic offline consumers switching to the online channel increase a little once both prices of firm 1 are equal. But as soon as firm 2's online price is reached, consumers divide between those channels and therefore the deep decline could be explained. Another interesting observation may be the contribution of the different sources of consumers to the total number of consumers in each channel. For the offline channel one can see that the major part of the total consumers b_{B_1} is made up of non switching consumers. At a price of 0.1 we observe 2.8 % offline consumers from the shared base which are not migrating, 95.7 % consumers from the extra base which are not switching and 1.3 % consumers migrating from firm 1's extra online consumers. As the offline price approaches the online price, the total offline consumers decline. Also the contribution of the different sources changes. At an offline price of 0.5, the contribution of the not switching shared consumers amounts to 15.3 % and is further rising till the online price of firm 2 is met. The ratio of not switching extra consumers drops to a mere 10.9 %, which is natural since the differences between both offline prices diminishes. After exceeding firm 1's online price the ratio declines to 2.3 % and decreases further. The fraction of extra consumers which do not migrate to an alternative channel also falls to 84.1 % and falls even further since the price advantage versus firm 2's offline price goes down. As the offline price of firm 2 is surpassed, this source of consumers drains and therefore their number becomes zero. It is also noteworthy that the contribution of firm 2's online consumers migrating towards firm 1's offline channel increases from 2.4 % at an offline price of 0.51 to 9.5 % at a price of 0.59 %. After exceeding firm 2's online price this source of consumers also runs dry. After even surpassing firm 2's offline price at 0.7, the remaining contributing source of consumers stems from not switching consumers of the offline channel. Certainly, this fraction is quite low at such price levels.

The contribution figures to the total online consumers b_{O_1} are quite different. Till firm 1's online price is met, the major contributors are non switching extra consumers from the online channel and offline consumers of firm 2 migrating towards firm 1's online channel. After exceeding that point, the main players appear to be consumers migrating from firm 1's offline channel towards its online channel. An additional source is also extra consumers captured due to lower online pricing than firm 2, which make up around 10 % between both online prices. Within that price range, firm 1 could also attract most consumers towards its online channel. Once firm 1's offline price exceeds firm 2's online price, the major contributors to the total online consumers still remain consumers switching from firm 1's offline channel, but the impact of extra online consumers not migrating is increasing. This is an effect of declining total online consumers due to fewer switching offline consumers. Therefore, the number of "fixed" extra consumers of the online channel becomes more and more important.

After it exceeds even firm 2' offline price the online price consists of almost entirely extra consumers of the online channel and not switching consumers from the online channel which are shared between both firms. Firm 1 could also attract consumers from both offline channels at a certain rate due to lower prices. After surpassing firm 2's offline price, both offline channels contribute around 10 % each to the total online consumer base of firm 1, but these levels are decreasing to less than 1 % in the end.

The figures in the second column, denoted by suffix *(2)*, result from firm 1's online price of 0.4, firm 2' offline price of 0.2 and its online price of 0.3. Again, the offline price of firm 1 varies. In the first figure an overview of each firm's consumers is presented. The difference to the former situation is evident. As firm 1's offline price reaches that of firm 2, the total offline consumer base b_{B_1} starts to decrease, the really harmful event happens when firm 2's online price is also surpassed. Firm 1's achievable consumers fall dramatically. Extra consumers offline also vanish as firm 2's offline price is touched.

The two remaining figures (*Consumer Drift Offline (2)* and *Consumer Drift Online (2)*) depict the situation in more detail. The basic offline consumers decline with the rise in the offline price. But one has to keep in mind that switching consumers have to be subtracted from these values. The number of consumers not switching from firm 1's offline channel drops at first at the crossing point with firm 2's offline price, secondly with firm 2's online price and finally with firm 1's online price. That issue is also visible in the decomposition of the online price. One can observe the spike in the number of consumers switching from firm 1's offline channel towards its online channel.

The contribution values for this scenario are quite different. The total offline consumers of firm 1 almost entirely depend on the non switching shared or basic con-

sumers. As the offline price is below firm 2's offline price, the non migrating extra consumers of the offline channel also add to the total offline consumers, but after surpassing firm 2's offline price more than 90 % of the total consumers stem from the basic offline consumers. Till the level of the online prices consumers could be persuaded to migrate to firm 1's offline channel but after even exceeding those levels, the non switching basic consumers alone make up the total consumers in the offline channel of firm 1. The total online consumers of firm 1 start to consist of basic online consumers not switching away till the offline price exceeds the online price at 0.4. Afterwards, the online channel attracts 88.9 % of its consumers from firm 1's offline channel. The number of basic online consumers not switching away drop to 11.1 % a share of total online consumers. Since the number of offline consumers declines with rising offline prices, the impact of those consumers decreases to 0.03 % in the end. In contrast, the fraction of basic online consumers being responsible for the total online consumers increases to 99.7 % in the same way. Note, since firm 1's online price is higher than any price of firm 2 no other source of consumers could be tapped.
The figures give a very raw overview of the interrelation. For a more detailed view refer to the corresponding Tables A.3 and A.4 in the appendix. However, the main picture is the following. There seems to be a kind of equal weight between both channels. The channel offering a lower price is able to attract consumers from other channels. If a channel obtains an advantage this value should be very low, which is confirmed by Table 10.4.

10.5 Pricing

The first important result is that firm 1 should keep a successful pricing strategy through the linear evolvement of consumers, i.e. the successful pricing strategy for an offline and online consumer base of one also proves successful if both consumer bases become 20, 40, 60, 80 and 100. Note that both consumer bases have to increase by the same amount in a linear fashion. Thus, if firm 1 exercises already a perfect pricing strategy at an offline and online consumer base of the same amount, and the number of available consumers is expected to double in each channel, firm 1 should simply do nothing. The current pricing policy will prove close to optimum.

			Market Environment
Profit	Max.	6.55904	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{B_2} = 1$
	Min.	0.06099	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$
Offline	Max.	26.06772	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{O_2} = 1$
Consumer	Min.	0.15190	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{O_2} = 1$
Online	Max.	29.81364	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$
Consumer	Min.	0.11902	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$
Offline Prices	Max.	0.40205	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{B_2} = 1$
	Min.	0.25037	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{O_2} = 1$
Online Prices	Max.	0.28848	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{O_2} = 1$
	Min.	0.18145	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$

Table 10.5: Results Summary

Table 10.5 presents an overview of the most interesting results. A more detailed overview of the results can be found in the appendix A.1.

The first result is that irrespective of firm 2's pricing and marketing activities (scenarios) the overall maximum profit for firm 1 could be reached in an environment where firm 2 offers online prices almost at its costs, offline prices like a monopolist and further conducts maximal effective offline marketing, neglecting any marketing efforts in the online channel. That offline price seems to be too high for that market situation and therefore the offline market is left to firm 1. Firm 1 prices at on average 0.28459 (Median 0.27039, Std.Dev. 0.037318), whereas firm 2 prices at 0.34649 in the offline channel. The offline market, where consumers exhibit higher reservation prices, is almost run by firm 1. Although the number of offline consumers which are captured in that market situation (25.97320) is close to the maximum, it already indicates the importance of the offline channel. Consumer drift pictures stress that issue very strongly. Total offline consumers consist of 57.7 % of not switching offline consumers and 39.5 % of not switching extra offline consumers. Together offline consumers make up 97.2 % of the total offline consumers. The influence of online consumers is negligible, which is natural since firm 2's online price is highly competitive.

The minimum profit firm 1 is able to make is in an environment in which firm 2 prices most aggressively in the offline channel, i.e. at its costs, conducts monopolistic pricing in the online channel and performs top marketing in the offline channel. This result could also be expected. The offline market is slightly more important for books, and just in that channel firm 2 prices at marginal costs. Thus, firm 1 is able to attack firm 2 by no means whatsoever as long as the number of online consumers remains low. Firm 1 conducts an average pricing of 0.33496 (Median 0.33814, Std.Dev. 0.00768), which is far above firm 2's offline price of 0.10001. The market left to firm 1 remains the online market. This part however could only become profitable if a certain number of consumers are available through this channel. If both consumer bases are 100 as in the maximum profit environment, the profit in the current scenario is not that far below the overall maximum, just the sources are different. In the current scenario with the maximal consumer bases firm 1 could earn a profit of 6.09880. The important issue is that this profit depends largely on online consumers which are not switching away from that channel. Although firm 2 prices a monopolistic price (0.21877) firm 1 could attack firm 2 in the online market. Firm 1 manages to receive the largest share possible in that sub market by pricing an average price of 0.19245 (Median 0.18372, Std.Dev. 0.02435) below its competitor's price and captures a large number of available online consumers which make up almost the amount of the overall maximum consumers ever acquired in the online channel (28.92044 versus 29.81364). But if the online market is negligible, firm 1 runs into trouble especially if the offline market turns out to be also very narrow.

The maximum offline consumers could interestingly be captured in an environment where firm 2 prices at its cost online, supported by an excellent marketing and prices monopolistically offline only. This outcome could be expected since the offline channel is again left to firm 1. Even more, since firm 1 always performs optimal marketing it could draw additional consumers to its offline channel because firm 2's marketing in the offline channel is zero. Although the offline price of firm 1 is higher than any online price, only a small fraction of offline consumers migrate to both online channels. The important thing is that firm 1 could manage to keep a large amount of its offline consumers. The number of offline consumers is almost entirely composed of not switching offline and extra offline consumers.

From that, it might be less surprising that the maximum number of online consumers could be generated in an environment where firm 2 prices at its costs offline and monopolistically online. Firm 2's perfect marketing is performed in the online channel. In such a situation firm 1 could draw a lot of consumers towards its online channel. The total number of online consumers is composed of 97.5 % of not switching online consumers.

Books seem to offer a well-balanced consumer structure in each channel. This feature allows firm 1 to attack firm 2 on the alternative channel. So if firm 2 starts to become price leader in one channel, firm 1 holds the option to become price leader in the alternative channel and will still be well off. Since no channel holds a large competitive advantage, switching will become small if prices are similar.

Chapter 11

Results Clothes

Clothes may be the other kind of products (Keeney 1999). Consumers may perceive huge differences purchasing apparel in the Internet. These products traditionally exhibit a necessity for sensory examination. For example, tactile offline experiences could not be replicated online. Consumers may not trust images in the online environment since colors may be distorted. Another issue refers to measures. It is hard to judge whether a purchased dress fits without trying it. Textual descriptions of sensory attributes do not satisfy consumers. It seems evident that the online channel has to overcome some obstacles when selling products such as clothes. (Chircu and Mahajan 2006). Further, return policies may also represent a hurdle (de Koster et al. 2002). Thus, consumers tend to utilize the offline channel for purchases where sensory attributes become important (Konana and Balasubramanian 2005, Gehrt and Yan 2004).
Results from the survey tend to support these issues. Most of the respondents undertake their typical apparel purchase through traditional stores. 254 consumers prefer the offline channel, whereas only 43 consumers utilize the online channel for purchasing clothes. This large difference seems to support the mentioned difficulties and risks when purchasing online. Traditional stores may hold some competitive advantage against online stores.

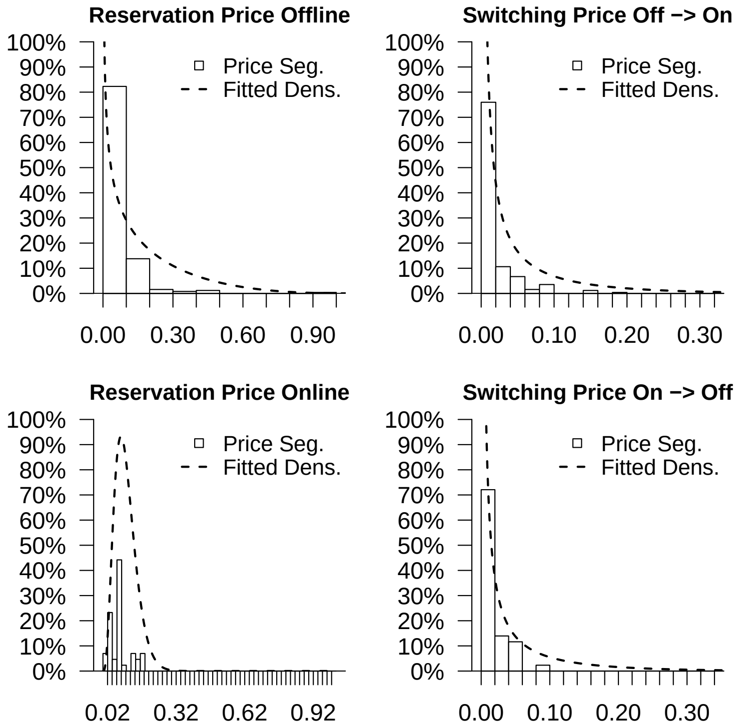

Figure 11.1: Frequency of Relative Price Statements

The estimates for the different Beta distributions are conducted by maximum likelihood and depicted in Figure 11.1. All prices are again normalized relative to the overall maximum of 1000. Those prices are typically paid by offline consumers at a usual purchasing occasion. The red lines again indicate the corresponding Beta density functions. Although the offline channel holds a competitive advantage over the online channel, a certain price range seems to be interesting for firms doing such business in the Internet. At a price range of 5 – 150 € the online channel could capture 86.9 % of its consumer base, whereas the offline channel is able to acquire 54.2 % of its initial consumer base. But due to the fact that the online consumer base adds up to a mere 16.9 % of the offline consumer base, absolute figures look very different. If we divide the price range into smaller pieces things may become clearer. At a price range of 5 – 50 € the offline channel retains 25.9 % and the online channel 13.6 % of each total available consumer base. Thus, in the low price segment the offline channel seems to exhibit advantages over the online channel. The findings further suggest that in an intermediate price range

the online channel may be able to strike back and capture most of its available consumer base. The high price segment is definitely held by traditional stores. Those are able to acquire 33.4 % of their total consumer base within a price range of 150 – 500 €, whereas in the online channel only 13.1 % of the available consumer base are conducting their purchase through this channel. Keeping these figures in mind, the offline market turn out to be the most important market for firms doing business in that industry. Thus, pricing may be strongly determined by the offline environment.
A typical observation regards switching probabilities. The data seem to indicate a lower propensity to switch for offline consumers. Therefore, firms performing an online business in that industry may not only be confronted with price sensitive consumers running away to the offline channel, but also with a very low consumer base compared to the offline environment. Individualization may be a way to overcome some obstacles of selling such sensory-intensive products.

	Shape Parameter	
	p	q
Offline Reservation Price	0.6453024	3.6127472
Online Reservation Price	4.0247430	37.1375760
Offline → Online Switching	0.11659230	6.29874870
Online → Offline Switching	0.09456613	6.40430122

Table 11.1: Parameter for the Beta Distribution

Table 11.1 gives the final parameters for each Beta distribution. Again, since intra-channel switching (S_{FOO} and S_{FBB}) was not part of the survey, these switching probabilities were eliminated from the model.

11.1 Marketing Strategies

The overall ranking of all available marketing strategies again is calculated in the same way as with books (see Equation 10.2).
On an individual basis, 225 participants voted assessment first place. This is not surprising since for this kind of products consumers regard sensory attributes persuasive for evaluating its utility. A fraction of 123 consumers ranked availability to

be most important for purchasing clothes in traditional stores. Availability may be a natural outcome, since without the item being available in the store, consumers could not judge its sensory attributes, which in the end makes no difference of purchasing in the Internet. Assortment with 23 votes for number one, counseling capturing 22 votes and quality retrieving 20 votes for first place follow on place. Assortment seems to be important. Since consumer tastes are individually different, assortment may prove important to satisfy each individual taste. Counseling may serve as a decisive selling proposition to attract consumers. Friendly sales personnel might be a good investment in industries where subjective tastes decide upon purchasing or not-purchasing (Hansen and Deutscher 1977, Bäckström and Johansson 2006). Finally, quality appears in the list of numerous number one votes. Subjective tastes may be evaluated by individual quality perceptions. Consumers affirm their expertise by touching the material and trying on the clothes (Balasubramanian et al. 2005, Verhoef et al. 2007). Quality therefore could only be judged by directly accessing the item. The online channel prevents consumers from evaluating the quality prior to the purchase.

In the online channel again convenience is rated to be most important. For 194 consumers convenience is the number one attribute regarding decisions to buy in the Internet. Almost at the same levels follow assortment, delivery time and return policy. Assortment is voted on first place by 45 participants. This result is very similar to offline consumers' demand for variety. As already mentioned tastes differ, the higher the available variety, the higher the probability that a consumer finds what he desires (Verhoef et al. 2007). A fraction of 42 consumers voted delivery time as number one. This behavior reflects consumers' preference for immediate consumption (Read and Loewenstein 1995). Thus, short and reliable delivery time may be an important marketing attribute to attract consumers to the online channel (Bakos 1997, Keeney 1999). Finally, 40 participants ranked return policy as number one. This outcome could be expected, because of subjective evaluations of product attributes. Consumers are able to judge the purchased product not until the item arrives at their home. Thus, high rates of uncertainty about sensory attributes unsettle consumers. Therefore, its is obvious that easy return policies may help to lower that uncertainty (Hansen and Deutscher 1977, Lim and Dubinsky 2004, Gehrt and Yan 2004).

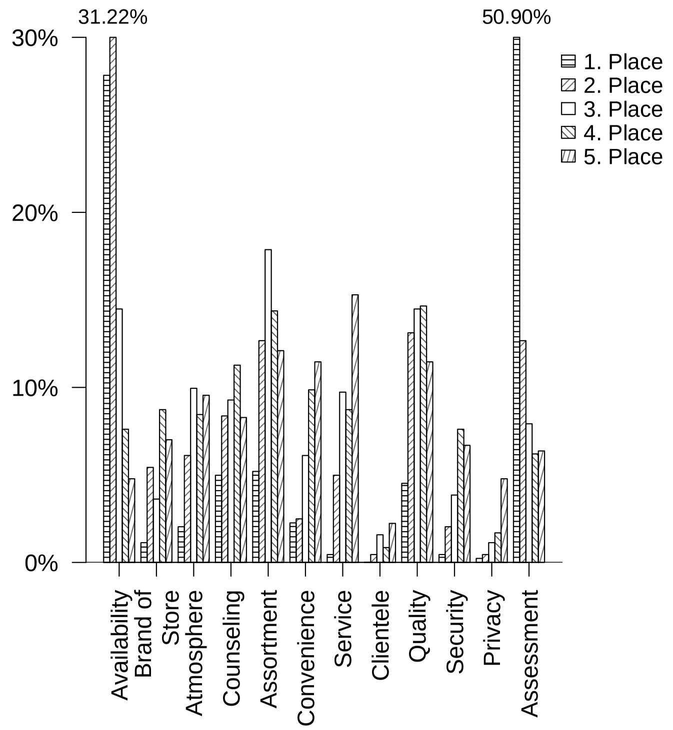

Figure 11.2: Importance of Marketing Attributes Offline

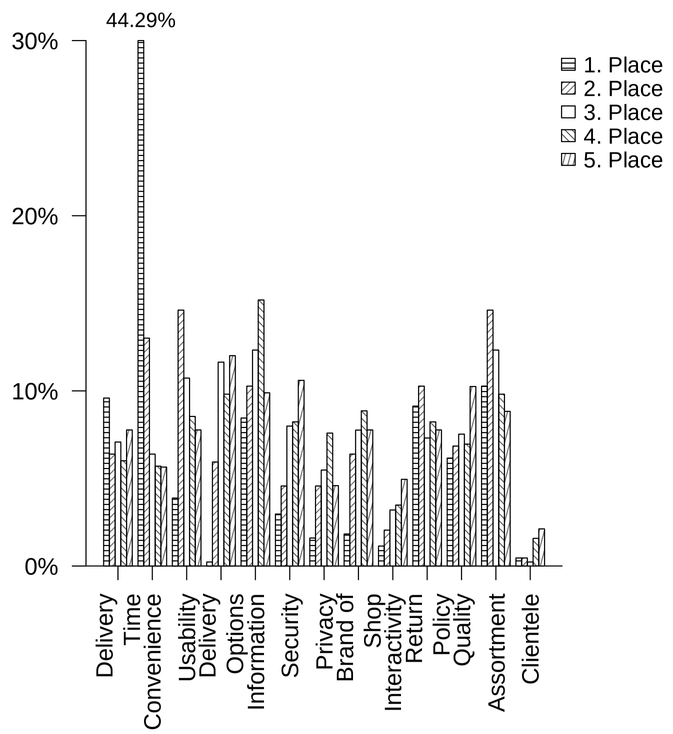

Figure 11.3: Importance of Marketing Attributes Online

Figures 11.2 and 11.3 depict the rankings for first place, i.e. most important attribute, up to fifth place. The tremendous importance of assessment in the offline channel is evident at first glance. This is already a huge difference to books. Obviously purchasing clothes is strongly linked to assessment. This should not be surprising. Clothes are products which consumers usually want to try on, touch, feel and see the fabric (Keeney 1999, Verhoef et al. 2007). The demand for these experiences may be a large obstacle to selling clothes online. That five times as many consumers preferring the online channel still choose the offline channel for purchasing clothes stresses that issue. The second most important feature, availability, is natural. If the desired product is not in stock an alternative shop will be visited.

For consumers buying online, again convenience, followed by assortment are the decisive factors. These factors should be optimally served by the Internet. An important factor, which may be caused by high uncertainty about experience factors (touching, feeling, seeing), is return policies for clothes.

Offline		Online	
Availability	0.11283186	Delivery Time	0.03848647
Brand of Store	0.01999052	Convenience	0.10808621
Atmosphere	0.02963021	Usability	0.04521147
Counseling	0.03847977	Delivery Options	0.02900664
Assortment	0.05657396	Information	0.05274672
Convenience	0.02220291	Security	0.02690002
Service	0.02662769	Privacy	0.02009399
Clientele	0.00331858	Brand of Shop	0.02690002
Quality	0.05246523	Interactivity	0.01126236
Security	0.01359039	Return Policy	0.04456328
Privacy	0.00434576	Quality	0.03459731
Assessment	0.11994311	Assortment	0.05914763
		Clientele	0.00299789

Table 11.2: Optimal Marketing Spending

Table 11.2 represents the total ranking (see Equation 10.2) of all available marketing attributes. Firms behaving accordingly will cause the maximum impact on consumers.

The figures in detail reveal nothing really new compared to the number one view. One interesting outcome is that counseling is no longer present above a 5 % level in the offline channel, whereas all others, notably assessment and quality, are still major factors for the offline environment.
In the online environment, information appears with a percentage of 5.2 % in the class of more important marketing attributes, while delivery time as well as return policy are no longer present above a 5% level. This is an interesting result but deeper insight might be gained be cross-comparing all three products.

11.2 Elasticity

As clothes seem to be more bound to the offline channel, the impact of offline pricing to consumers in that channel should be high.

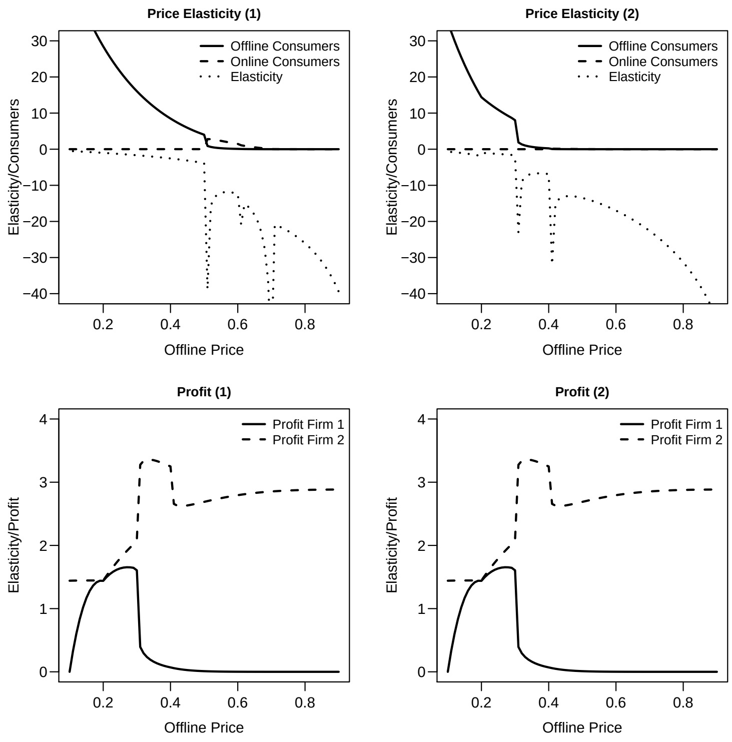

Figure 11.4: Price Elasticity versus the Offline Price of Firm 1

Figure 11.4 shows the elasticities of offline prices, offline and online consumers of firm 1 as well as profit shapes of both firms. The Figures *Price Elasticity (1)* and *Profit (1)* depict the dynamics related to an increasing offline price of firm 1 subject to firm 1's online price of 0.4 and firm 2's offline and online prices of 0.7 and 0.6 respectively. As firm 1's offline price exceeds its online price, a notable change in the number of consumers can be observed. The interesting part comes into view as firm 1's offline price also exceeds firm 2's online price. A small kink in the profit shape and almost no influence on the current number of consumers materializes. Things become very different as firm 1's offline price reaches and exceeds firm 2's offline price. Firm 1's profits falls apart, whereas firm 2's profits soar. The importance of the offline channel is more pronounced in the figures *Price Elasticity (2)* and *Profit (2)* of Figure 11.4. The relatively low online price of firm 2 seems to have almost no impact on firm 1's offline consumers or its profits. The dramatic impact stems from firm 1's offline price exceeding firm 2's offline price. The resulting drop in offline consumers and the decline in profits are apparent.

11.3 Mean and Variance

The picture of a clothes environment should be different to books, since most consumers prefer purchasing clothes through traditional stores.

	Offline	Online	Both
Mean Reservation Prices	0.09232283	0.09779070	0.09311448
Variance of Reservation Prices	0.00853055	0.00212655	0.00759677
Mean Markup	0.01921260	0.01548837	0.01867340
Variance Markup	0.00083912	0.00047764	0.00078672

Table 11.3: Results Summary

Table 11.3 displays different values from the survey. The Mann-Whitney test on offline prices being lower than online prices turns out to be highly significant below a 5 % confident interval (p-value=0.006181). From this result, one could deduce that offline reservation prices are lower than online reservation prices on average. For the level of desired markups no significance was found.

The variance in reservation prices also seems to be congruent. Interestingly, the Ansari-Bradley test reveals online markups to be less dispersed than offline markups (p-value 0.01029), i.e. online consumers seem to hold more clear ideas of their desired markup if they were forced to purchase in the offline channel. The lower variance may also be explained by the comparably low number of consumers purchasing in the online shop.

11.4 Consumer Drift Dynamics

For clothes a huge competitive advantage for the offline channel comes into light. This fact is already stressed by Figure 11.1. Utilizing Equations 10.3 and 10.4 we get the competitive advantage of the offline channel at zero and the competitive disadvantage of the online channel at 0.8307087. Remember that positive numbers indicate discounts which are required in that channel to make consumers at least indifferent between both channels.

OF_{IBO}	0
OF_{IOB}	0.8307087
OF_{FBO}	0
OF_{FBB}	-
OF_{FOB}	0.8307087
OF_{FOO}	-

Table 11.4: Initial Offset Values

Table 11.4 depicts the large disadvantages of the online channels. Firms which like to implement a well-balanced pricing strategy in each channel to minimize switching have to grant a deep discount of about 0.8307087 in the online channel. Otherwise consumers tend to move to traditional stores.

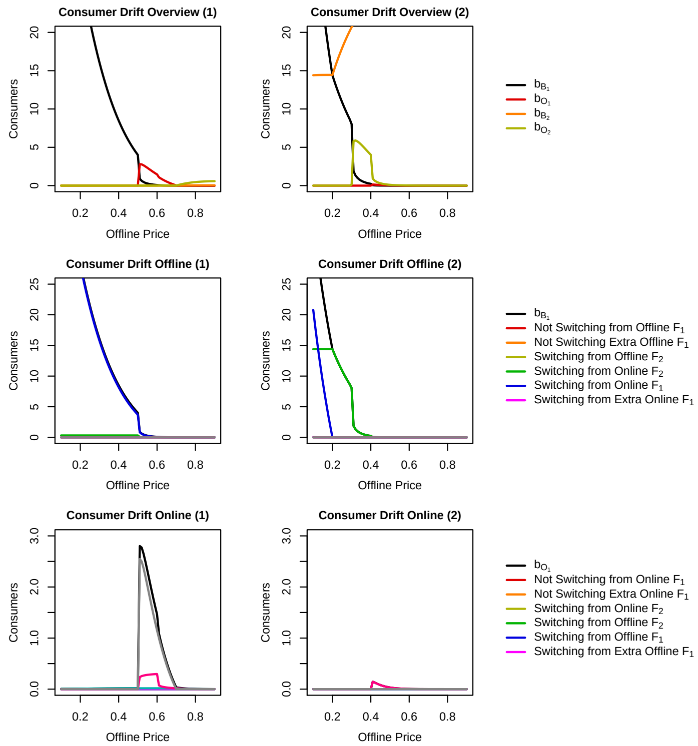

Figure 11.5: Elasticity

Figure 11.5 presents the composition of consumers in each channel for firm 1. For clothes again the same scenarios as for books are applied. Column one displays consumers' behavior at firm 1's online price of 0.5 and firm 2's offline and online price of 0.7 and 0.6, respectively. Again, total consumers of firm 1's offline channel b_{B_1} decrease as the corresponding price increases. At the level of firm 1's online price a radical drop in that number of consumers could be observed. Note that consumers migrate to firm 1's online channel b_{O_1} at that point. The figure *Consumer Drift Offline (1)* underlines that argument. The number of extra offline consumers not migrating to the online channel drops as the online price of firm 1 is met. Note that still a number of extra consumers are generated through lower pricing in firm 1's offline channel compared to firm 2's offline channel. But as the figures point out, those are switching towards the online channel. Further, note the slight difference between the not switching extra consumers or the extra consumers in general and the total consumers in the offline channel b_{B_1}. This means that above firm 2's offline price of 0.7 almost no consumers are available. Thus, firm 1's offline base is almost overall composed of extra consumers due to lower pricing. The share of total online consumers b_{O_1} is almost insignificant. This may again indicate the importance of the offline channel for purchasing clothes. The figures also show that the increase in online consumers is driven by migrating consumers, not by consumers obtained from the channel itself. Thus, the online channel could hardly obtain consumers due to its pricing. The argument of the importance of the offline channel becomes even more weighty if the composition of total offline consumers b_{B_1} within both online prices is observed in detail. One could observe that offline consumers are almost entirely built of consumers not switching away from that channel. The fraction of consumers migrating from firm 2's online channel towards firm 1's offline channel due to lower pricing is negligible.

The figure *Consumer Drift Online (1)* displays the previously mentioned drift behavior again. Total consumers online rise as the offline price meets the online price. The effect is mainly driven by extra offline consumers migrating to the cheaper online channel of firm 1. Additionally, a small fraction of consumers of firm 1's basic offline consumers also start switching towards its online channel. This share of consumers drops as firm 2's online price is met. Also note the small decrease in total online consumers b_{O_1} as the online price of firm 1 is surpassed. This might also indicate the almost negligible power of the online consumers.

The contribution figures of this scenario are different than with books. First, consider the ridiculously small amount of basic consumers in the offline as well as in the online channel. That indicates that firm 2's offline and online price both are far too high for the current market (see Table 11.3). Remember that basic or shared offline consumers are determined by the highest offline price in the economy. For the basic online price the calculation is adequate. Therefore, it is not surprising to see extra offline consumers to be the major source of consumers for firm 1's offline channel in the beginning and keep on being dominante until firm 2's offline price is surpassed. Interestingly, the offline channel of firm 1 is able to attract consumers from each online channel of the environment due to its low price. Just before the offline price hits firm 1's online price, the main contributors to the total offline consumers are non switching extra offline consumers (92.8 %) and non switching basic offline consumers (7.2 %) of firm 1.

Online consumers also migrate to the offline channel but their magnitude is too small to become relevant. Thus, the offline channel appears strong to attract consumers, which again underlines the importance of the offline channel for such products. After exceeding firm 1's online price, the major source of offline consumers stems from firm 1's extra offline consumers, which amounts between 80 % and 94 % till firm 2's offline price is met. Afterwards this source of consumers dries up naturally. The remaining source of consumers becomes not switching basic consumers from the offline channel.

In the beginning total online consumers are entirely based on offline consumers of firm 2 migrating to firm 1's online channel due to distinctive lower pricing. Until firm 1's online price is met by its offline price, the single source of online consumers remains switching consumers of firm 2's offline channel (almost 100 %). It is interesting to note that the online channel itself is not able to attract consumers. Throughout the variations of firm 1's offline price the contribution of the non switching online consumers and the non switching extra online consumers remains insignificant. When firm 1's online price is met by its offline price, consumers start to migrate to its online channel due to its lower price. Therefore, the main parts of total online consumers are switching offline consumers and switching extra offline consumers of firm 1. But if firm 2's offline price is surpassed the source of extra consumers is ebbing. From that point on the components of the total online consumers are switching offline consumers of both firms. At the crossing point, i.e. each offline channel prices equally, each offline channel donates exactly 50 % of the total online consumers. Since firm 1's offline price is still rising, the contribution of that channel declines, whereas firm 2's contribution increases. However, the total amount of online consumers drops further after the crossing point.

The second column gives the results for firm 1's online price of 0.4 and firm 2's prices of 0.2 in the offline and 0.3 in the online channel. A similar picture as with books emerges. Total offline consumers drop dramatically after exceeding firm 2's online and offline prices. At the level of 0.2, firm 1 loses all its extra consumers due to lower pricing. The second figure shows that issue in more detail. The number of not switching offline consumers almost vanishes as the offline price of firm 1 exceeds its online price. Not switching extra offline consumers disappear as the offline price exceeds firm 2's offline price. More interesting may be the last figure concerning the online channel of firm 1. Since both prices of firm 2 are below firm 1's online price, firm 1 is not able to capture any extra consumers. Even worse, the basic consumers remain at low levels. Consumers migrating from firm 1's offline channel show a spike after the offline channel price surpasses the online channel price. This spike results in an increase in total online consumers b_{O_1} of almost the same amount. The price in the online channel of firm 1 already seems too high to capture a significant fraction of consumers. Contribution figures for this scenario again show very extreme values. Until firm 2's offline price is met, the total offline consumers of firm 1 consist of non switching offline consumers and non switching extra offline consumers. Both sources add up to approximately 99 % of the total offline consumers. After that point the unique source of offline consumers remains non switching offline consumers. Sure there are some consumers migrating from both online channels towards the offline channel of firm 1, but the number of consumers in both channel stays too low to make significant contributions.

As mentioned previously, clothes seem to have low mean reservation prices (see Table 11.3). The total online consumers of firm 1 on the other hand start to rely on non switching online consumers. But after firm 1's offline price surpasses its online price this channel is able to attract some consumers from the offline channel. Thus, right after the crossing point the total online consumers of firm 1 are almost entirely composed of firm 1's offline consumers migrating to its online channel (99.9 %). Since the offline price is still rising, the magnitude of these migrating consumers' influence declines. In the end the major contributors to firm 1's total online consumers are made up of 2.5 % migrating offline consumers of firm 1 and 97.5 % not switching online consumers.

The weakness of the online channel is evident. At certain points the online channel is not able to prevent consumers from switching away. On the other hand, the offline channel shows sticky consumers. It holds power to capture consumers from the offline as well as from the online channel. Although online consumers are quite low due to too high pricing a large fraction is migrating towards the offline channel. So firms should keep in mind the strong effect of the offline channel for such products.

11.5 Pricing

The strategy, like with books, of keeping a successful pricing strategy on linear changes of consumers bases of both channels no longer exists. For clothes things appear different. The reliable pricing strategy of books works just in certain situations. Firm 1 could stick to its prices in environments where firm 2 prices at its cost in the offline channel and therefore monopolistically in the online environment. In such situations firm 1 could keep its well-working pricing strategy as long as both consumer bases change by the same amount. If the market situation is different, that strategy would fail to return maximal profits.

			Market Environment
Profit	Max.	7.09419	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{O_2} = 1$
	Min.	0.02023	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{B_2} = 1$
Offline	Max.	20.79750	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{O_2} = 1$
Consumer	Min.	0.08345	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$
Online	Max.	18.40330	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{O_2} = 1$
Consumer	Min.	0.00001	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$
Offline Prices	Max.	0.65763	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{O_2} = 1$
	Min.	0.21202	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{O_2} = 1$
Online Prices	Max.	0.69821	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$
	Min.	0.10001	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$

Table 11.5: Results Summary

Table 11.5 gives an overview of the most interesting results. A detailed overview of the results can be found in the appendix A.2.

The overall maximum profit can be achieved in an environment where firm 2 prices at its costs in the offline channel, commanding monopolistic pricing in the online channel and exercising perfect marketing in the online channel. A profit of 7.09419 could be reached by firm 1. Firm 1 follows a clear rip-off strategy in such a situation. Although the offline market is the more interesting one, firm 1 prices extraordinarily high in that channel, on average about 0.49345 (Median 0.55142, Std.Dev. 0.12798). But one has to note here that at times when the online consumer base is extremely small compared to the offline base, i.e. at every circumstance when the online consumer base is one, firm 1 reverses its strategy.

In such situations firm 1 prices both channels almost equally to minimize cannibalization. This strategy is obvious. As long as the online consumer base is not profitable, firm 1 has to face the strong pricing of firm 2 and tries to offer competitive prices. If there is no price range left for offering its own competitive pricing, firm 1 chooses to minimize cannibalization. As soon as the online market becomes profitable, firm 1 strikes back and offers highly competitive prices in the online environment and just exploits the offline channel with high prices. Usually, online prices turn out to be on average 0.11480 (Median 0.10024, Std.Dev. 0.04893). So, firm 1 undercuts firm 2's online price, which is at 0.13882. One can see that firm 1 as well as firm 2 both act with highly aggressive pricing policies in that market environment.

The smallest profit firm 1 is able to generate stems from an environment in which firm 2 prices monopolistically with an excellent marketing in the online channel and, further, commands prices at cost level in the online channel. As the monopolistic price firm 2 announces 0.27423 in the offline channel. Although firm 1 at times undercuts this price and sometimes even tries to compete in the online channel with similar prices as firm 2, profits stay small. It seems that such situations allow almost no competitive action for firm 1. Firm 1 again tries to implement a similar rip-off strategy as in the scenario where it achieves maximum profits. So it commands relatively high offline and extremely low online prices. Since firm 2's online prices are also quite low, almost no extra consumers could be attracted. Although firm 1 undercuts firm 2's offline price, the discount seems to satisfy consumers less. These results appear also in similar situations, i.e. each time firm 2 prices monopolistically offline and at its cost level online irrespective of the marketing investments. This situation forms a perfectly undesirable market environment for firm 1, since even the monopolistic pricing in the offline channel turns out to have competitive strength.

Regarding the maximum consumers, firm 1 is able to attract most offline consumers in a market situation where it also generates its highest profits. Interestingly, though, firm 1 offers extremely low prices in the online channel. The result is that firm 1 generates a large number of extra consumers in the online channel. But due to the channel advantage of the offline channel, they tend to migrate towards the offline channel. Almost 90 % of the offline consumers stem from switching online consumers.

Another interesting thing is that the maximum attainable online consumers occur in scenarios which display five times as many online consumers as offline consumers. These consumers are attracted from not switching extra online consumers alone. Profits turn out to be less, since to capture all online consumers firm 1 prices extremely low in the online channel and prohibitively high in the offline channel, so that migration is minimized.

To summarize the findings: if firm 2 is strong price leader in the offline channel. Since the offline channel is the more important one for products like clothes, firm 1 has to conduct an alternative strategy. Firm 1's strategy is to draw online consumers towards its offline channel. This strategy proves to be successful at times when firm 2 prices monopolistically in the online channel. Firm 1 undercuts that price, attracts consumers and some of them tend to migrate to firm 1's offline channel due to the channel advantage. There is little place for firm 1 to perform its own pricing strategies, it rather has to react to firm 2's competitive pricing in such environments.

Chapter 12

Results Digital Camera

Digital cameras are highly technical items. Descriptions of such devices encompass technical attributes like focal length, insolation and resolution. It may become difficult for consumers to evaluate all items and furthermore bring that information in line with their needs. On the one hand a comprehensive description of digital cameras would easily be achievable within the online environment. Technical attributes entirely describe a camera and are usually given in real numbers. Comparison may no longer be as simple as with books, but with all relevant information consumers should be able to come up with an optimal purchase decision. Unfortunately humans suffer some cognitive limitations, which do not allow them to process such a big load of complex information. Therefore, suboptimal decisions may arise due to information overloads (Malhotra 1982).

Although all relevant information could be presented in the online environment, some consumers may long for counseling or testing the product. This behavior may arise as a result of too much technical information. Technophile consumers may show less fear of not getting what they want, other may secure themselves by asking sales personnel or testing the camera themselves.

To estimate the shapes of the various distributions we received 302 price statements from consumers favoring online shops and 127 consumers preferring to purchase in the offline environment. The difference is surprising. Around twice as many consumers of the offline channel utilize the alternative online channel for performing their digital camera purchase.

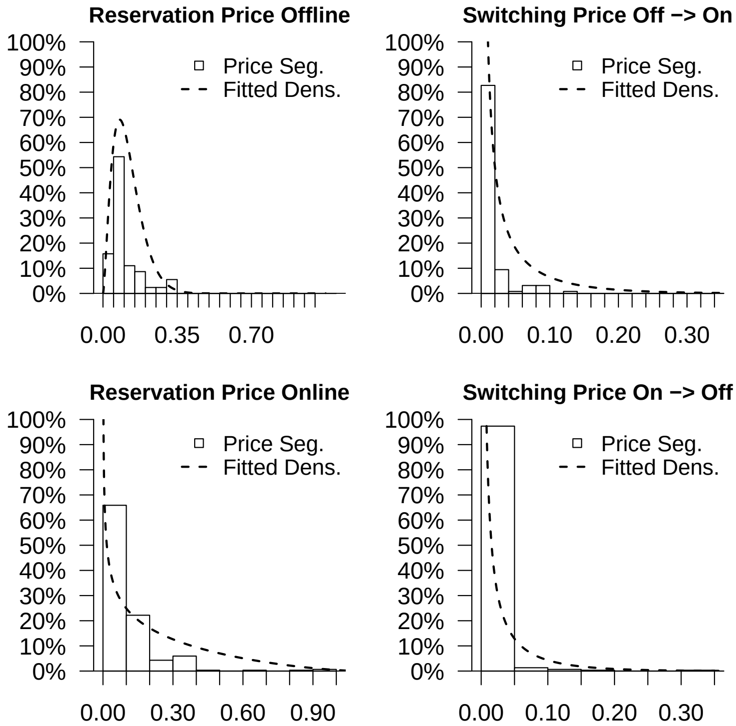

Figure 12.1: Frequency of Relative Price Price Statements

Figure 10.1 displays the frequency of all price statements relative to the overall maximum of 3000 paid at a usual purchasing occasion. The Figures *Reservation Price Offline* and *Reservation Price Online* show the prices at which the digital camera was actually bought. The required markup for switching to the alternative channel is depicted in the other figures. Again, the whole price range of digital cameras is normalized at 3000 and therefore all prices are between zero and one. The red lines again mark the estimated Beta density functions for the prices and markups.

The overall highest price paid for digital cameras now stems from the online channel. Further, reservations prices online appear higher than in the offline channel. This indicates the importance of the online channel relative to the traditional channel. Because of consumers' inherent higher reservation prices in the online channel, consumer rents may be higher, which makes this channel more interesting for firms. This fact is underlined by differences in obtainable consumers. At a price of 0.5 the firm is able to achieve 11.3 % of the total online consumer base but at the same price almost no consumer from the offline base is willing to purchase digital cameras.

Nevertheless, this is not the whole story. The offline channel holds its advantages in the lower price segment. If we take the number of consumers which could be reached by a price range from 100 € to 300 €, a firm could reach about 33.4 % of the total consumer base in the offline environment and a mere 13.8 % in the online environment. This may be due to an assortment offering lower prices in the offline channel, so that digital cameras in the offline channel may even be bought as the consumers pass by the store.

Higher priced digital cameras perform very differently. Within a price range of 500 – 1000 € the online channel takes over. For such items a firm could attract 23 % of the online consumers but the number of interested offline consumers falls to 17.9 %. In this case one may hypothesize about increased information demand. The online channel could present an overwhelming amount of information. Another assertion may be that high priced items are bought by consumers who “know what they do”, i.e. technically affine consumers who have some expertise with digital cameras and are able to judge the quality of these items by just comparing data sheets. If we take the increased information demand of 6.6 % (see Figure 12.3) for such items in the online channel into account, this statement might contain some relevance.

Regarding the propensity to migrate towards an alterative sales channel, a similar result as with books materializes. Offline consumers appear to exhibit less propensity to switch than online consumers. Thus, the online channel may be the more interesting channel but pricing should be done very carefully.

	Shape Parameter p	q	Distribution at the Model
Offline Reservation Price	2.5848580	20.4944280	R_B
Online Reservation Price	0.6788757	2.46354660	R_O
Offline → Online Switching	0.1388618	8.97627020	S_{IBO}, S_{FBO}
Online → Offline Switching	0.0983261	10.16078696	S_{IOB}, S_{FOB}

Table 12.1: Parameter for the Beta Distribution

The shape parameters for the Beta distributions are given in Table 12.1. Again, since intra-channel switching (S_{FOO} and S_{FBB}) was not part of the survey, these switching probabilities were eliminated from the model.

12.1 Marketing Strategies

Concerning the most favorable marketing strategies total ranking is calculated as with books (see Equation 10.2).

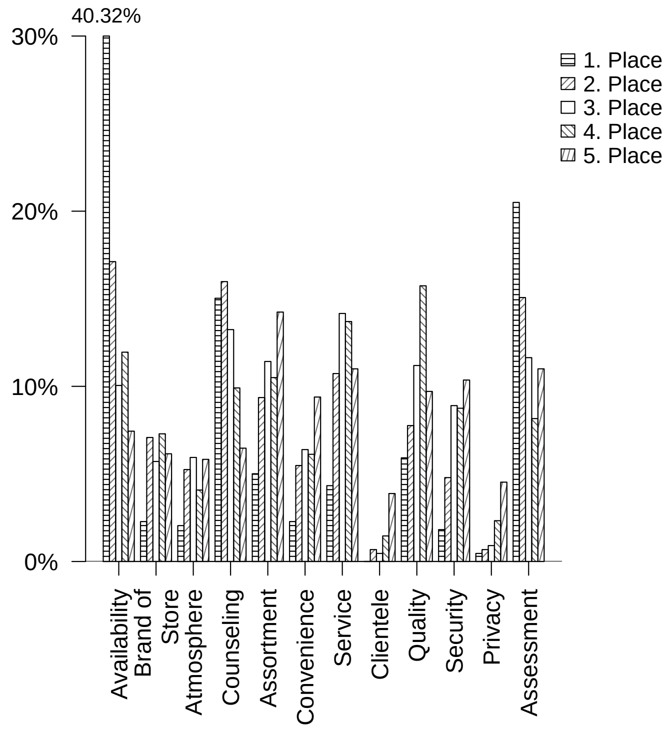

Figure 12.2: Importance of Marketing Attributes Offline

For digital cameras 177 consumers in the offline channel demand availability as the most important attribute and 90 participants regarded the opportunity of assessment to be most important (see Figure 12.2). At last 66 consumers appreciated counseling and voted it number one (e.g., Hansen and Deutscher 1977, Bäckström and Johansson 2006). The major influence of assessment and counseling may suggest that less technically affine consumers purchase through traditional store environments since both activities could reduce consumers' perceived risks.

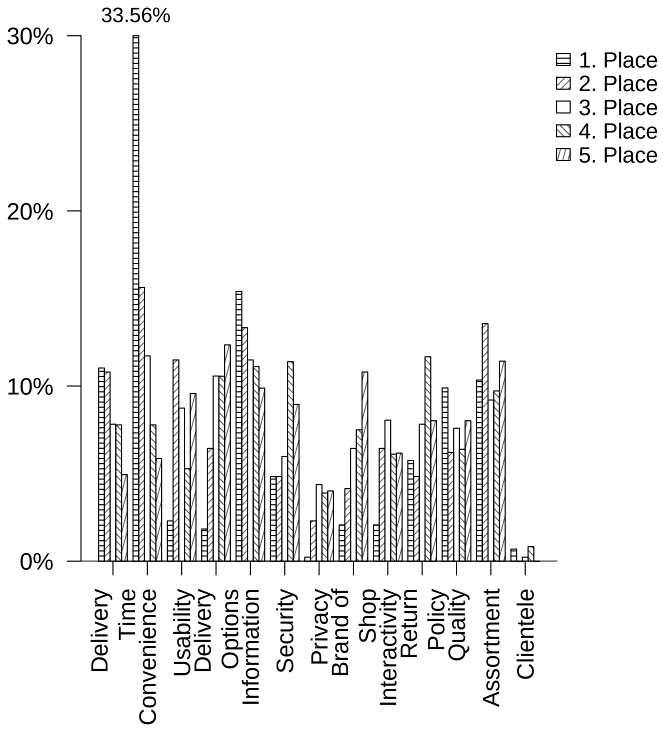

Figure 12.3: Importance of Marketing Attributes Online

In the online environment (see Figure 12.3) a share of 146 consumers regarded convenience to be the most important attribute for online channels. This attribute is typical for this environment since its description consists of 24/7 and home delivery. Thus, this attribute is some kind of "natural" online attribute (e.g., Donthu and Garcia 1999). Information on the other hand, which was voted by 67 consumers as number one, may also be provided in traditional stores. However, in the online environment the evaluation of that information is bound to consumers. Data sheets and technical descriptions provide guidance, but comparing and weighing those parameters against each other is left to the consumer. Thus, one may ascertain online consumers to be more technically informed and hold higher expertise than an average offline consumer (e.g., Donthu and Garcia 1999). Another important attribute is delivery time. Delivery time may be perceived as additional costs (e.g., Bakos 1997, Liang and Huang 1998). Thus, immediate delivery may improve perceived shopping experience and shed a positive light on the online channel (Soopramanien and Robertson 2007).

Offline		Online	
Availability	0.113650895	Delivery Time	0.048052363
Brand of Store	0.025415601	Convenience	0.098180077
Atmosphere	0.020859974	Usability	0.034562580
Counseling	0.069693095	Delivery Options	0.032407407
Assortment	0.043158568	Information	0.066171775
Convenience	0.024056905	Security	0.030172414
Service	0.047714194	Privacy	0.011414432
Clientele	0.003196931	Brand of Shop	0.023148148
Quality	0.044037724	Interactivity	0.026021711
Security	0.026614450	Return Policy	0.033604725
Privacy	0.005115090	Quality	0.039431673
Assessment	0.076486573	Assortment	0.054916986
		Clientele	0.001915709

Table 12.2: Optimal Marketing Spending

Table 12.2 shows in which marketing activities firms should invest. The values represent the percentage values of optimal investments in different marketing operations which maximize the effect on consumers. These values show the total ranking (see Equation 10.2).

Note that taking a 5 % boundary for important activities, availability, assessment and counseling appears to be most effective in the offline environment. In the online channel, convenience, information and assortment turn out to be most important. Assortment seems to be supported by the price range. Higher priced products, premium digital cameras may be hard to find in traditional stores. Online stores offer the necessary depth of assortment to serve “power-users” demand (Lim and Dubinsky 2004, Verhoef et al. 2007).

12.2 Elasticity

Digital cameras attract a large fraction of consumers to the online channel. Developing a sophisticated online strategy may be important for successfully selling digital cameras to maximize profits.

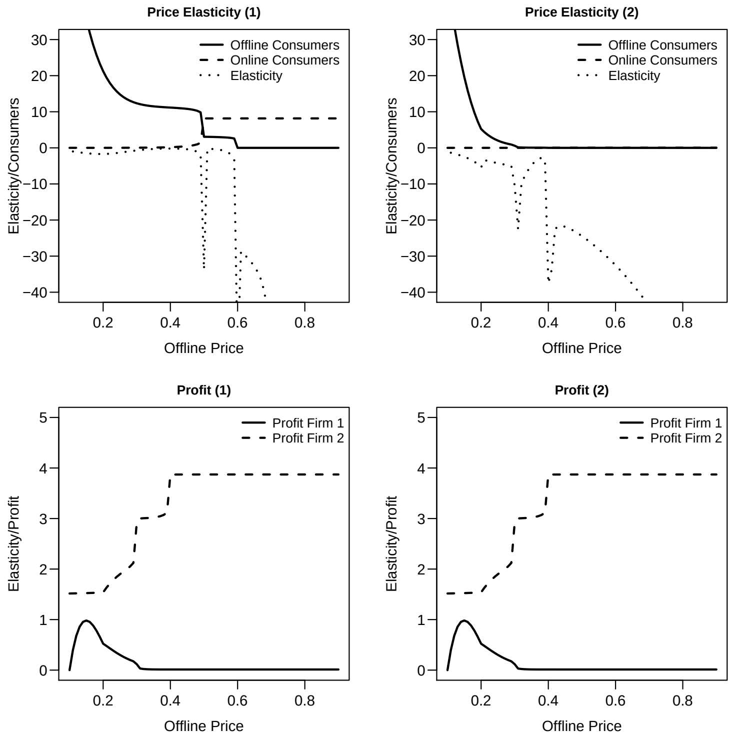

Figure 12.4: Price Elasticity versus the Offline Price of Firm 1

Figure 12.4 represents the elasticities of offline prices, offline and online consumers of firm 1, as well as profit shapes of both firms. The Figures *Price Elasticity (1)* and *Profit (1)* depict the following: The first peak in the price elasticity of offline consumers shows firm 1's offline price exceeding its online price (0.5). There is a decline in offline consumers corresponding to the increase in online consumers. Consumers are shared among both channels of firm 1. The impact emerges when firm 1's offline price exceeds firm 2's online price (0.6). The importance of the online channel seems to be clear. Declining offline consumers as well as a dramatic drop in profits occur. Online consumers of firm 1 are almost not affected by that event. This should be normal, since firm 1's online price undercuts firm 2's online price. It is also interesting to note that the elasticity to prices decreases as the offline price approaches firm 1's online price, i.e. less reaction of consumers to hikes in the offline price. The spike as the offline price equals the online price of firm 1 may be explained by high sensitivity of consumers at this point since switching is now an alternative. This is recognized by declining offline consumers combined with expanding online consumers if the offline price is increased further. Although the online channel is now available, elasticity of the offline consumers bounces back to levels prior to equal offline and online prices. Afterwards, if the offline price of firm 1 exceeds firm 2's online price (0.6) the decline in the elasticity is enormous. This may also emphasize the importance of the online channel. The last spike when firm 1's offline price finally tops firm 2's offline price (0.7) causes almost no effect on firm 1's profits or consumers. Further, decreasing elasticity appears normal since the offline price of firm 1 is highest in such an environment. This issue is underlined by the importance of the online channel which makes the offline channel almost negligible.

The Figures *Price Elasticity (2)* and *Profit (2)* of Figure 12.4 display a different setting. The first small kink relates to firm 2's online price of 0.2 being met by firm 1's offline price. Compared to previous descriptions the price elasticity of offline consumers starts to decline immediately. The online price of firm 2 is competitive right from the start. Elasticity levels rest clearly below the ones of Figure *Price Elasticity (1)*, i.e. consumers more easily leave firm 1's offline channel on further price increases. This issue can be seen in the offline consumers' curve. Another observation is also that firm 1's profits decline as firm 2's profits soar. As the offline price of firm 1 meets the one of firm 2 at 0.3, things become even worse. Firm 1's offline consumers almost vanish, as do profits. One interesting observation is that as firm 1's offline price approaches its online price consumers' elasticity lessens. This may indicate lower intra-firm switching due to negligible price differences between both channels of a firm. Thus, similar pricing in both channels may be good advice for firms. As soon as firm 1's offline price exceeds its online price at 0.4, the price elasticity of its offline consumers decreases dramatically since its offline price turns out to be the highest price in the environment.

12.3 Mean and Variance

	Offline	Online	Both
Mean Reservation Prices	0.11093440	0.12856180	0.12334340
Variance of Reservation Prices	0.00563761	0.01401316	0.01157963
Mean Markup	0.0158163	0.00966115	0.01148339
Variance Markup	0.0005420	0.00068258	0.00064752

Table 12.3: Results Summary

Again, Table 12.3 presents various values from the survey. These values should give a first sign on differences due to the product class. The first result is that offline reservation prices are significantly lower than online reference prices. The Mann-Whitney test yields a p-value of 0.03098. This result also emphasizes the importance of the online channel for doing business in the digital camera market. Online consumers seem to be willing to spend more than offline consumers.

12.4 Consumer Drift Dynamics

In contrast to clothes, a huge competitive advantage for the online channel appears with digital cameras. That issue was already prominent in Section 12.1. Again, utilizing Equations 10.3 and 10.4, the competitive disadvantage of the offline channel amounts to 0.5794702, whereas the online channel provides no disadvantage at all. Please note that a firm setting prices in the offline channel should offer discounts at 0.5794702 to attract consumers indifferent between the online and the offline sales channel.

OF_{IBO}	0.5794702
OF_{IOB}	0
OF_{FBO}	0.5794702
OF_{FBB}	-
OF_{FOB}	0
OF_{FOO}	-

Table 12.4: Initial Offset Values

Table 12.4 shows the competitive weights in detail. All switching offsets from an offline channel towards any online channel show positive numbers, which indicates the pecuniary disadvantage of the offline channel. Therefore, consumers rather tend to purchase in the online environment.

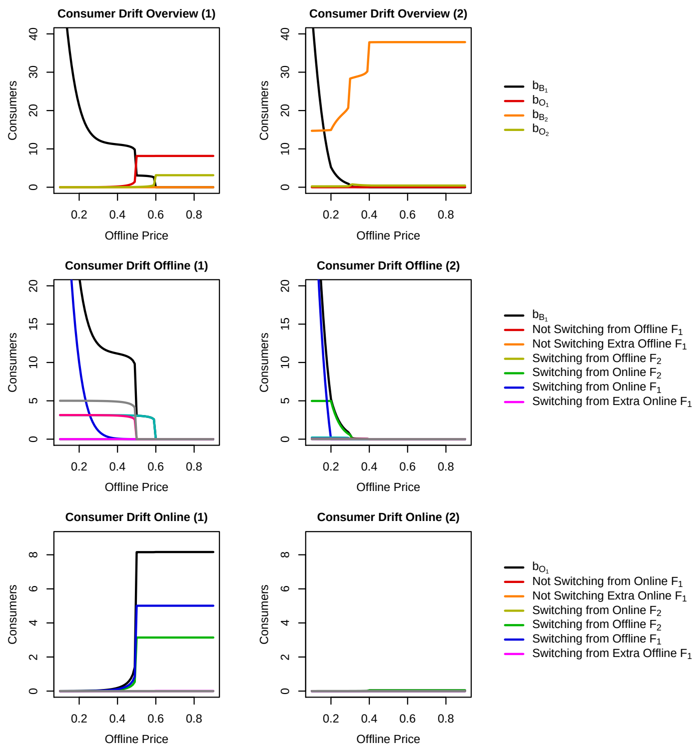

Figure 12.5: Elasticity

Figure 12.5 again displays the composition of consumers in each channel for certain conditions. The eye-catching differences to books and clothes are apparent and will be discussed in detail. The first column displays results for a scenario consisting of firm 1's online price of 0.5, firm 2's offline price of 0.7 and its online price of 0.6. The total consumers of firm 1's offline channel b_{B_1} start to decline immensely at a price level of around 0.3 already. Afterwards the number of total offline consumers does not drop further in such a dramatic fashion till firm 1's online price is met. A similar shape could be also observed with extra offline consumers. They also decline very fast towards the level of firm 1's online price. The severe decrease in total online consumers may be a first sign of the power of the online channel. As the online price of firm 1 is surpassed, the total online consumers b_{O_1} go up and remain almost stable at a certain level. One can see that as soon as the online price is met no consumers switch from the online channel towards the offline channel. The online channel can keep its consumers and additionally adds some migrating consumers from the offline channels. Almost the whole share of online consumers at this point stems from online consumers due to online pricing. Only a small fraction comes from migrating consumers. The level of basic consumers of firm 2, which is the same for firm 1 since firm 1's online pricing is lower than firm 2's, remain stable. The same is true for the extra online consumers. But keep in mind that these values are reduced by switching consumers. Note also that the number of total offline consumers b_{B_1} finally falls, as the level of firm 2's online price is exceeded.

The magnitude of offline consumers is also driven by migrating online consumers. As long as firm 1's offline price is still lower than firm 2's online price, consumers switch from the online channel to the offline channel. Again, the offline channel itself could not attract a significant fraction of consumers. This matter also emphasizes the importance of the online channel for selling digital cameras.

The Figure *Consumer Drift Offline (1)* shows the drifting situation for total offline consumers b_{B_1} in detail. One can see large contributions of both online channels to the amount of offline consumers. The values of switching consumers from firm 1's online channel, firm 1's extra consumers online and firm 2's online consumers make up almost the whole offline consumers above an offline price level of around 0.3. This threshold indicates low price consumers in the offline channel and again the importance of the online channel.

The last figure in the first column (*Consumer Drift Online (1)*) represents the composition of total online consumers b_{O_1}. Note the sharp increase in this amount at the crossing point with firm 1's online price. A slight increase follows till the online price of firm 2. As one can see total consumers online consist primarily of consumers of the online channel, since the major parts are consumers not switching from the online channel and extra consumers of the online channel also not switching.

Contribution figures of this scenario are again different from books. Just before the offline price hits firm 1's online price, the main contributors to the total offline consumers are switching extra online consumers (42.2 %) and basic online consumers (26.5 %) of firm 1 and migrating online consumers of firm 2 (31.3 %). Note that the offline channel itself is not able to attract a significant fraction of offline consumers. Certainly, extra offline consumers determine the number of total offline consumers at very low offline prices. But as the offline price rises these consumers vanish and consumers migrating from both online channels make up the total offline consumers of firm 1. Migration occurs since the offline price is lowest in the environment. The interesting composition of total offline consumers may be a first hint regarding the importance of the online channel. After exceeding firm 1's online price, the major source of offline consumers is firm 2's online channel, which amounts to almost 100 %. The severe drop of total offline consumers of firm 1 after exceeding that price level stresses that point. The numbers of offline consumers and extra offline consumers do not play a significant role in the composition of total consumers. When firm 1's offline price finally exceeds firm 2's online price, the last source of consumers for its offline channel dries up. Now the total offline consumers are composed of not switching extra and basic offline consumers. The total number of offline consumers attracted at this price level is almost negligible, nevertheless.

Total online consumers consist throughout the whole situation of around 38.5 % not switching online consumers and 62.4 % not switching extra online consumers. All other sources of consumers contribute just insignificant fractions of consumers to be added to the number of total online consumers. This again shows the importance of the online channel, since before the offline and online prices of firm 1 are equal, large fractions of online consumers migrate to the offline channel of firm 1. After exceeding that level those consumers stick to the online channel.

The second column shows a different picture. Now firm 1's online price is at 0.4, but firm 2 prices 0.2 and 0.3 in the offline and in the online channel respectively. The number of total offline consumers b_{B_1} drops strongly at the level of firm 2's offline price. Nevertheless, the total offline consumers of firm 1 are composed of consumers of the offline channel not switching away, since both online prices are still higher. When the level of firm 2's online price is met, a further slump occurs. Now consumers migrating from firm 2's online channel soar. Total consumers offline are now composed of consumers still not switching away from that channel and approximately one third of consumers migrating from firm 1's online channel. While the number of consumers not switching from the offline channel decreases as the level of firm 1's online price approaches, the number of online consumers switching towards that channel remains fairly stable. Thus, the number of total offline consumers becomes more and more dependent on migrating online consumers. Finally, as the price level of firm 1's online channel is reached, this source of consumers also vanishes and the number of offline consumers becomes negligible. In contrast, the online channel captures those former migrating consumers and further draws consumers from the offline channel. The number of total online consumers b_{O_1} is almost entirely composed of consumers not switching from the online channel.

The composition of the total offline consumers consists of 68 % not switching offline consumers and 28.6 % not switching extra offline consumers right before firm 2's offline price is surpassed. The contribution of firm 1's online channel is less than one percent. This low fraction could be explained by the low number of consumers attracted to the online channel because almost all online consumers migrate to the offline channel. A price of 0.4 seems to be far too much to attract consumers to the online channel in the current situation. As firm 2's offline price is surpassed, the number of extra consumers dries up. Therefore, the impact of consumers switching from both online channels to firm 1's offline channel starts to become more important. Just before firm 2's online price is met, the composition of the total offline consumers of firm 1 consists of 76.5 % not switching offline consumers, 19.1 % switching online consumers of firm 2 and 4.4 % consumers migrating from firm 1's online channel. Naturally the impact of firm 2's online consumers is higher. This is due to the lower online price of firm 2, which allows firm 2 to attract extra online consumers compared to firm 1's online channel. Thus, the number of online consumers is larger for firm 2. Finally, as the online price of firm 1 is met by firm 1's offline price, the single source of offline consumers remains not switching offline consumers. Note again the importance of the online channel. Just before the offline and online prices of firm 1 are equal, the total number of offline consumers is composed of 6 % not switching offline consumers and 94 % online consumers of firm 1 migrating to its offline channel.

Total online consumers almost entirely consist of not switching online consumers of firm 1. Since the given online price is very high and until the offline price exceeds its level of 0.4, which represents also the maximum price in the whole environment, only a small number of consumers are attracted by this price. Note that as the offline price exceeds the online price, a considerable hike in total online consumers takes place. On the other hand the fraction of offline consumers now migrating to firm 1's online channel is not significantly contributing to the total amount of online consumers. This may also indicate the importance of the online channel for selling digital cameras.

All these figures depict the importance of the online channel. In the first column the online channel takes command as soon as the offline price surpasses the online price. Since the online price of firm 1 is the lowest in the economy, firm 1 could make a good profit irrespectively of the offline pricing. The second column mirrors the economy. Firm 2 prices lowest in each channel. Obviously firm 1 could no longer maintain the profit level from the previous scenario. However, as the offline price rises, firm 1 is able to preserve some profit from the online channel.

12.5 Pricing

For digital cameras a similar pricing strategy like with books is applicable for linear rises in both consumer bases of the same amount, i.e. both consumer bases in each channel exhibit an amount of one, 20, 40, 60, 80 and 100 consumers available. The close to optimal pricing strategy for an environment in which both consumer bases offer one consumer each is also applicable for consumer bases of 20 each and so on. Although almost the same optimal prices emerge for such situations, slight differences remain.

Table 12.5 gives an overview of the most interesting results. A more detailed overview of the results can be found in the appendix A.3.

Digital cameras seem to be the opposite of clothes. As noted earlier the more interesting market with this product is the online market, since reservation prices proved to be higher. Note that surprisingly the maximum profit for firm 1 could be acquired in an environment where firm 2 commands cost-plus pricing in conjunction with an excellent marketing in the offline channel and pricing like a monop-

			Market Environment
Profit	Max.	8.76540	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$
	Min.	0.04192	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{O_2} = 1$
Offline	Max.	27.52518	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{O_2} = 1$
Consumer	Min.	0.00000	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{O_2} = 1$
Online	Max.	47.85159	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$
Consumer	Min.	0.16620	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{B_2} = 1$
Offline Prices	Max.	0.71083	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{O_2} = 1$
	Min.	0.10002	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{B_2} = 1$
Online Prices	Max.	0.47742	$p_{B_2} = \tilde{p_{B_2}}$, $p_{O_2} = 0.10001$, $\xi_{O_2} = 1$
	Min.	0.23462	$p_{O_2} = \tilde{p_{O_2}}$, $p_{B_2} = 0.10001$, $\xi_{B_2} = 1$

Table 12.5: Results Summary

olist in the online channel. Obviously firm 2's strategy reveals two shortcomings. First, firm 2 makes all its marketing effort in the offline channel, which is the less profitable one. Second, the monopolistic price in the online channel seems to be too high. Therefore, firm 1 could generate a profit of about 8.76540 with prices of 0.10006 and 0.28317 in the offline and in the online channel respectively. Consider the differences given firm 2's pricing, which is 0.10001 and 0.336469. One can see that firm 1 prices clearly below firm 2 in the online channel and additionally fights in the offline channel. The effect is obvious. In the offline channel, firm 1 captures as many switching-willing consumers as possible. The number of total consumers offline of firm 1 is composed of 65.7 % not switching offline consumers and 34.3 % online consumers migrating to its offline channel due to that price advantage. In the online channel on the other hand, firm 1 manages to attract as many consumers as possible due to the channel advantage of digital cameras. The number of total online consumers therefore is composed of 26.6 % not switching online consumers and 73.4 % consumers migrating from any channel of firm 2 towards firm 1's online channel. It might be not surprising that the overall maximum of online consumers occurs also in that scenario.

The least profitable environment for firm 1 turns out if firm 2 combines monopolistic online pricing with excellent online marketing and cost-plus offline pricing. This situation is unfortunate for firm 1 again in two ways, and very similar to the maximum profit environment, except for the marketing. First, firm 2 again follows a very strict low price policy in the offline channel and firm 1 again tries to challenge it. The problem is that this time, although firm 2's online price rests again above firm 1's online price (0.33647 versus 0.24474), firm 2 could counter by utilizing its perfect marketing strategy in the online channel. With the help of marketing the pecuniary advantage of firm 1 is lessened. Although again around 66.8 % of the offline consumers stem from migrating consumers of firm 2, the picture in the online channel has changed. This time the total online consumers of firm 1 consist of 72.0 % not switching online consumers and only 28.0 % consumers migrating from firm 2. Here resides the big difference towards the environment where firm 1 could get off with maximum profits.

The smallest number of offline consumers appears in an environment where firm 2 prices at its cost in the online channel, conducts perfect marketing in the online channel and additionally prices monopolistically in the offline channel. Since the monopolistic offline price of firm 2 is quite low (0.15908), firm 1 could not even get a significant fraction of offline consumers as long as the available offline consumer base remains small, i.e. one. Note that in such a situation firm 1 also prices highest in the offline channel, just to exploit the few consumers which stay in their offline channel. Surprisingly that environment also shows the highest online price and the largest offline consumers. If the offline consumer base grows, firm 1 starts to decrease its offline price to levels just above its costs. As the offline consumers reach 100, firm 1 starts to exploit online consumers. This behavior is natural since the market is captured by firm 2 with its cost-plus pricing. Thus, firm 1 attracts a large number of offline consumers by its cost-plus price in the offline channel. The total number of offline consumers consists of around 88.0 % not switching offline consumers. So firm 1 could successfully grab the offline market and get away with a profit too.

The digital camera market shows the importance of the online channel for doing business. The power of the online channel is undoubted but there is an exit route for the opposite firm if the alternative channel is left over. This firm could successfully apply a profitable pricing strategy in the offline channel.

Chapter 13

Cross-Comparison

In this section a comparison of all three products is presented. Differences should help to draw conclusions for similar products. The first apparent differences stem from the shapes of the reservation prices. Books take up a moderate position. The extreme poles are clothes and digital cameras. Clothes show the offline channel to be most important for doing business. Even more, the offline channel reveals a tremendous competitive advantage of 0.8307087. So pricing in the offline channel should deeply impact a firm's overall pricing strategy. On the opposite end, digital cameras display the online channel to be most profitable. A competitive advantage of the online channel of 0.5794702 could also be observed. Note that these figures describe a general behavior. For both products it is important to note that depending on the pricing range the alternative channel becomes more profitable. Another interesting observation is that for all three products it turns out that offline consumers tend to be more state-dependent than online consumers.

The most fundamental result may be that firms could run into the wrong pricing if they do not regard the whole reservation price structure. If a firm bases its pricing on average prices, this strategy could harm a firm's profits. If a firm knows the whole reservation price shape, more accurate pricing decisions help to avoid losses.

Further, price elasticity seems to be strongly affected as soon as a firm prices highest in a market, i.e. a further price hike would result in a higher loss of consumers than it would be the case with the lowest price in the economy. At the beginning of the price hikes consumers' price elasticity rests in a range conform to existent literature (Bijmolt et al. 2005, Png 2004, Simon 1992). But as the price reaches regions above competitive prices, the increase in price elasticity might be harmful to a firm's profits. Thus, firms should be aware of the price structure of their opponents to set prices in an appropriate range.

Next, different products require different channels. For products which utilize sensory attributes, the offline channel may be the more important sales channel. If a firm intends doing business in the online channel, special quality measures may be demanded by the consumers, e.g. return policies. The relevance of different marketing activities also differs for each product.

The first impressive result is that for clothes assessment is the most important attribute for purchasing offline. This is a clear difference to digital cameras and books. The Mann-Whitney test reveals highly significant results regarding a higher impact of assessment for clothes versus the other products (p-value $1.913e^{-7}$ and $4.664e^{-13}$ for books and digital cameras respectively). Thus, if firms intend to sell clothes through the Internet consumers, may demand special discounts for reducing their risk or simple return policies.

Second, consumers purchasing products like books and digital cameras demand availability as most the important attribute. This is not surprising since the preference for immediate consumption has been long known (e.g., Read and Loewenstein 1995). Books show another interesting attribute significantly different from both other products. Atmosphere in the traditional shop is regarded highly by offline consumers. This may be the cause why books, although they inhere typical features of digital information goods, are still bought through traditional stores. The p-value for the Mann-Whitney test gives values of $3.974e^{-5}$ and 0.01795 for clothes and digital cameras respectively.

A third interesting result comes from digital cameras. Consumers purchasing digital cameras offline demand significantly more counseling than for books or clothes (p-value of $5.567e^{-5}$ and $2.2e^{-16}$ for books and clothes respectively). This result may indicate a higher cognitive effort in purchasing digital cameras.

If we take a closer look at the relevant online attributes, some interesting results also appear. As we might have guessed return policies are indeed a striking attribute for selling clothes online. A firm doing business in the Internet with such a product should take care to have well established return policies. The Mann-Whitney test emphasizes the difference to books and digital cameras since it results in a p-value of $8.56e^{-6}$ versus books and 0.0007002 versus digital cameras. Digital cameras require a large amount of information to foster purchases. In the offline channel therefore counseling is a demanded attribute. For the online channel the corresponding attribute might be information. Indeed, higher demand for information was found with digital cameras (p-value of 0.002855 and 0.008525 for books and clothes respectively). This high demand for information might be the cause why a larger fraction of survey participants prefer the online channel for purchasing digital cameras. Firms should therefore emphasize information if they sell technical items like digital cameras on the web. Consumers may regard that with higher profits and loyalty (e.g., Flavián et al. 2006a, Shankar et al. 2003).

For books little differences regarding the most important attributes were found. Delivery time turned out to be no more important for books than for all other products. Nevertheless, assortment shows a difference versus digital cameras. While assortment of books versus clothes turns out to be not significantly higher, digital cameras require less assortment than books (p-value 0.02637). Thus, firms doing online business in the clothing and books industries should emphasize a large assortment. If we take a look at successful firms like Amazon or Otto, this argument seem to be plausible and confirmed.

Comparing the consumer drift dynamics, books appear to be somewhere in a "middle" position. The extreme positions are held by clothes on the one side and digital cameras on the other side. While for clothes the offline channel contributes most of the total consumers of the offline channel, the impact of these consumers appears to be negligible for digital cameras. For digital cameras migrating online consumers make up the major part of the total offline consumer base. As these consumers erode, a significant slump in total offline consumers could be observed. The opposite extreme, represented by clothes, shows the importance of the offline channel. Almost the whole contribution towards the total amount of offline consumers stems from not switching offline consumers. For the number of total online consumers things are reversed. For clothes major parts migrate from both offline channels, whereas for digital cameras the number of total online consumers almost entirely consists of not switching online consumers.

These findings are highlighted by the results in the situation where firm 1's online price is fixed at 0.4. Here the environment is more competitive since at a certain point firm 2 prices both channels below firm 1. One can see the dependence on migrating online consumers and the severe eroding of total offline consumers as migration disappears for digital cameras. For clothes an immense reliance on offline consumers could be observed. Here total online consumers depend on migrating offline consumers.

These extreme poles emphasize the importance of knowing the market. A firm should be well aware where its consumers come from. A proper pricing policy should at first serve the preferred or performing sales channel. If that can not be accomplished, the other channel could be utilized to draw consumers from the performing channel as in the digital camera case.

Finally, a short comparison of different pricing strategies in a certain situations should be made. The maximum profit for clothes and digital cameras could be earned in an environment where firm 2 prices cost-plus in the offline channel, and monopolistically in the online channel. This result might be puzzling. The difference is made by marketing. While for clothes, firm 2 leaves the offline market to firm 1, the latter firm could maintain that market with an appropriate marketing strategy and therefore attract a maximum of offline consumers. In the digital camera case firm 1 is able to maintain the online market with its marketing and generate a maximum of online consumers.

This result gives rise to important notes. A firm should carefully analyse the reservation price structure of its product. If we assume the same reservation price structure for both products we should expect the maximum profit in the clothes case with firm 2 pricing monopolistically in the offline channel and at its costs in the online channel, since the offline channel is the more important one for clothes. As we could observe, the shape of the reservation prices alters these expectations in a dramatic way. The remaining variations in marketing still pronounce the difference regarding channel profitability. For books, where the higher yielding market is the offline channel, the expected outcome occurs. The profitable scenario is the one in which firm 2 prices monopolistically in the offline channel and at its costs in the online channel. What remains insightful is that firm 2 also performs excellent marketing in the offline channel. Apparently the monopolistic price is too high, so firm 1 still has enough range to operate its pricing. The composition of the total offline consumers stresses that argument.

For the number of consumers in each scenario, books are very similar to clothes. This should not be surprising since both products show some advantage in the offline channel. The single exception remains the situation where the maximum offline consumers could be obtained. For both products this happens when firm 2 prices monopolistically in the offline channel and prices at its cost combined with perfect marketing in the online channel. This should be expected, firm 2 prices too high in the offline channel, leaving a competitive price to firm 1. For both products the prices are able to attract almost all of their offline consumers from the offline channel and persuade them not to migrate. The interesting question is why for clothes this obvious argument is not true. Admittedly the offline consumer base remains large in that scenario, but for a certain condition an even higher number of offline consumers could be achieved for clothes. In a situation where firm 2 prices monopolistically supported with an excellent marketing strategy in the online channel, and at its cost in the offline channel, firm 1 has no chance in the offline channel. But it could offer incredibly low online prices and due to the pecuniary advantage of the offline channel a large fraction, especially from the extra consumers of the online channel, start to migrate towards the offline channel. That is exactly what happens with clothes.

From the different pricing strategies two results could be drawn very clearly. First, firms should know their consumers' reservation prices. Second, keep an eye on excellent marketing. As it could be seen, firm 1 always manages to perform marketing activities close to the optimum and in certain situations competitor's price advantages could be mediated.

Chapter 14

Conclusion and Limitations

The research goal was to design a model which may help marketers in their pricing decision. The problem of setting prices in parallel in two sales channels emerges with the rise of the Internet. Most firms operate two sales channels nowadays. Thus, the pricing problem becomes a relevant topic. Since most firms still use cost-plus pricing, this model should show alternatives which may prove more profitable (e.g., Noble and Gruca 1999, Simon 1992). Setting prices in the real world without thinking about it may result in losses. This model should help marketers to apply their pricing strategies in a virtual environment to test their ideas. From different scenarios they could conclude the success or failure of different pricing strategies. Further, the model should be applicable in a quick and easy way. The demand of data to feed the current model is very low. Only reservation prices are needed to set up the model. It represents a simple model but offers clear lines how consumers may move through the environment. Because of its simplicity it may suffer some drawbacks which will be discussed in the limitations section.

14.1 Conclusion

The model applied proves to be very powerful in showing interesting results and giving hints for marketers of different products. The most striking result may be the important power of knowing the shape of reservation prices. By knowing that, a firm could already conduct very decisive pricing. Differences in optimal pricing strategies for various products highlight that issue. If we remember the two poles of products, digital cameras and clothes, the first important difference is the consumers' preferred channel. While for clothes the offline channel is the channel of choice, for digital cameras the online channel turns out to be more relevant. This difference is reflected in different pricing strategies. While the profit maximizing scenario of both products appears similar (except for marketing), pricing is as different as it could be. For clothes the successful strategy is to transfer online consumers towards the offline channel by undercutting the competitor's online price. Almost all the profit stems from the offline channel. For digital cameras on the other hand it appears more important to draw consumers from the offline channel towards the online channel, and finally the profit is composed almost entirely of online consumers. These results are determined by different distributions of reservation prices. The impact is overwhelming. So those examples illustrate difficult differences in products and their accurate pricing. The model could help to develop appropriate pricing strategies for each product. Firms should be aware of using average prices for their pricing decisions. They may be completely wrong and not even notice it.

A second result is that excellent marketing strategies may help to lower a price advantage of a competitor. The scenarios where the competitor performs incorrect marketing actions give an opportunity for a firm to either attract additional consumers, or to command higher prices without losing consumers. So wise marketing may serve as a differentiation attribute, which may result in increased profits. Note that firm 1 always conducts excellent marketing. As there is enough money, it should be spent accordingly. It makes no sense to invest in improper marketing since it would not affect consumers. This could be an entry for further research since marketing activities should be evaluated on their efficiency to optimize such investments.

A third interesting result is that price elasticity depends crucially on the price structure of the market. As long as a firm's price is the lowest in the market, it could increase the price and suffer the usual loss of consumers comparable with existent literature (Tellis 1988). As soon as alternative price levels are reached elasticity soars. Especially crossing points are marked by spikes in elasticity since consumers start to migrate at once. Note that with the highest price in the whole economy, the highest elasticity of prices is associated. Thus, firms should be aware of the surrounding price levels and try to price lowest.

There are also some remarkable differences regarding marketing activities. Books show that the store atmosphere is an important distinctive asset. This might be the cause why traditional bookshops still exist although online shops offer higher convenience. For clothes, assessment and return policies are demanded by consumers more than for other products. This might be the reason why most consumers prefer traditional stores to purchase clothes. Firms doing online business with clothes should keep a sharp eye on return policies. By developing a sound return policy, consumers' fears of online shopping might be reduced. Conversely digital camera consumers demand information and counseling. This complex product could be described very well in the Internet. Thus, a firm should provide all relevant information to satisfy consumers.

The different weights of marketing attributes magnify the differences in the purchase behavior of various products. Firms should utilize these differences and provide consumers with their desired marketing activities since accurate marketing positively influences profits.

14.2 Limitations

Although the model is very exhaustive there is still place for possible extensions. First, one could also let extra consumers migrate to any channel. This is the most important limitation in the current model. Extra consumers for a certain channel are there due to the lower price in that channel. If they intend to migrate to an alternative channel it is assumed that they stay within the same firm. The argument goes as follows. Consumers typically strive for the lowest price. When they finally find the channel offering the lowest price, but they prefer the alternative channel for undertaking the purchase, they stick to the selected firm. Johnson et al. (2004) also found that consumers only visit 1.2 book sites for a typical purchase. Second, the intra-channel switching probabilities S_{FOO_1} and S_{FBB_1} have not been observed. Common sense would imply that switching within the online market is much higher than switching within traditional stores because in the Internet the competitor is just one click away and price comparison sites foster such behavior. The effort to visit numerous traditional stores is higher beyond comparison. Another interesting field of expansion could be to incorporate the impact of marketing activities on reservation prices. Common sense would support that view.

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Appendix A

Detailed Tables

A.1 Books

Price Offline	Consumer Offline	Consumer Online	Elasticity	Profit F_1	Profit F_2
0.1	70.84695	0.04800	-0.31893	0.01920	0.01025
0.12	66.38925	0.05473	-0.38678	1.34968	0.01166
0.14	62.16521	0.06184	-0.45736	2.51134	0.01313
0.16	58.15483	0.06930	-0.53100	3.51701	0.01464
0.18	54.34272	0.07709	-0.60803	4.37825	0.01618
0.2	50.71650	0.08517	-0.68880	5.10572	0.01775
0.22	47.26591	0.09353	-0.77368	5.70932	0.01932
0.24	43.98219	0.10214	-0.86309	6.19836	0.02088
0.26	40.85773	0.11102	-0.95749	6.58165	0.02241
0.28	37.88577	0.12017	-1.05739	6.86751	0.02392
0.3	35.06021	0.12963	-1.16340	7.06390	0.02537
0.32	32.37549	0.13947	-1.27621	7.17840	0.02677
0.34	29.82642	0.14981	-1.39664	7.21827	0.02810
0.36	27.40812	0.16083	-1.52570	7.19044	0.02936
0.38	25.11593	0.17282	-1.66465	7.10159	0.03054
0.4	22.94524	0.18623	-1.81518	6.95807	0.03164
0.42	20.89134	0.20187	-1.97972	6.76598	0.03267
0.44	18.94903	0.22120	-2.16253	6.53115	0.03361
0.46	17.11147	0.24745	-2.37375	6.25911	0.03449
0.48	15.36521	0.29063	-2.66590	5.95503	0.03532
0.5	12.93878	1.11884	-39.08513	5.62305	0.03612
0.52	2.13272	10.42826	-10.31370	5.06705	0.03693
0.54	1.40785	9.75481	-8.85212	4.52138	0.03781
0.56	0.99358	8.86574	-8.43351	4.00334	0.03889
0.58	0.71956	7.92766	-8.50396	3.51645	0.04055
0.6	0.46940	6.99721	-22.71431	3.03358	0.07126
0.62	0.23159	4.57761	-13.07310	1.95147	0.12235
0.64	0.14217	3.62422	-15.29811	1.52646	0.11755
0.66	0.07967	2.76376	-19.82566	1.15012	0.11240
0.68	0.03570	1.97924	-31.84796	0.81240	0.10760
0.7	0.00510	1.26553	-14.96648	0.50927	0.10328
0.72	0.00315	1.20207	-15.45569	0.48278	0.41610
0.74	0.00194	1.15221	-16.10656	0.46213	0.69661
0.76	0.00118	1.11267	-16.91847	0.44585	0.94591
0.78	0.00071	1.08117	-17.90518	0.43295	1.16521
0.8	0.00042	1.05608	-19.09375	0.42273	1.35585
0.82	0.00024	1.03620	-20.52747	0.41465	1.51921
0.84	0.00013	1.02057	-22.27295	0.40833	1.65680
0.86	0.00007	1.00847	-24.43434	0.40344	1.77022
0.88	0.00004	0.99929	-27.18116	0.39974	1.86115
0.9	0.00002	0.99254	-0.31893	0.39703	1.93143

Table A.1: Elasticity Scenario α ($p_{O_1} = 0.5, p_{B_2} = 0.7, p_{O_2} = 0.6$)

Price Offline	Consumer Offline	Consumer Online	Elasticity	Profit F_1	Profit F_2
0.1	46.24483	0.00105	-0.49353	0.00032	3.82420
0.12	41.74753	0.00121	-0.61849	0.83531	3.82993
0.14	37.50371	0.00140	-0.75992	1.50057	3.83398
0.16	33.48582	0.00161	-0.92275	2.00963	3.83717
0.18	29.67221	0.00185	-1.11352	2.37433	3.84022
0.2	26.04624	0.00213	-0.67097	2.60526	3.84371
0.22	24.31978	0.00247	-0.75291	2.91911	4.02047
0.24	22.67464	0.00286	-0.84078	3.17531	4.19032
0.26	21.10341	0.00333	-0.93695	3.37754	4.35487
0.28	19.59750	0.00389	-1.04675	3.52872	4.51755
0.3	17.21402	0.00460	-23.03356	3.44418	5.04666
0.32	3.07782	0.00549	-5.82083	0.67877	7.73155
0.34	2.11733	0.00669	-4.95207	0.51017	7.78937
0.36	1.56143	0.00844	-4.70721	0.40850	7.77149
0.38	1.18542	0.01146	-4.72523	0.33536	7.72510
0.4	0.85620	0.07240	-32.03208	0.27858	7.85225
0.42	0.11917	0.60947	-10.76702	0.22098	6.16454
0.44	0.06780	0.50869	-9.77685	0.17566	6.14372
0.46	0.04146	0.41786	-9.58050	0.14028	6.16647
0.48	0.02612	0.34236	-9.67729	0.11263	6.20612
0.5	0.01668	0.28119	-9.93332	0.09103	6.25360
0.52	0.01072	0.23231	-10.29705	0.07420	6.30459
0.54	0.00689	0.19364	-10.74505	0.06112	6.35669
0.56	0.00442	0.16334	-11.26606	0.05103	6.40842
0.58	0.00281	0.13983	-11.85507	0.04330	6.45882
0.6	0.00178	0.12178	-12.51080	0.03742	6.50724
0.62	0.00111	0.10807	-13.23452	0.03300	6.55324
0.64	0.00068	0.09778	-14.02951	0.02970	6.59650
0.66	0.00042	0.09017	-14.90093	0.02728	6.63684
0.68	0.00025	0.08462	-15.85582	0.02553	6.67413
0.7	0.00014	0.08064	-16.90334	0.02428	6.70832
0.72	0.00008	0.07784	-18.05525	0.02340	6.73939
0.74	0.00005	0.07590	-19.32653	0.02280	6.76737
0.76	0.00003	0.07459	-20.73645	0.02239	6.79232
0.78	0.00001	0.07373	-22.31016	0.02213	6.81432
0.8	0.00001	0.07318	-24.08111	0.02196	6.83347
0.82	0.00000	0.07284	-26.09505	0.02185	6.84990
0.84	0.00000	0.07264	-28.41669	0.02179	6.86375
0.86	0.00000	0.07252	-31.14155	0.02176	6.87517
0.88	0.00000	0.07246	-34.41857	0.02174	6.88432
0.9	0.00000	0.07243	-0.49353	0.02173	6.89140

Table A.2: Elasticity Scenario β ($p_{O_1} = 0.4, p_{B_2} = 0.2, p_{O_2} = 0.3$)

Profit	Price	Cons. Offline	Cons. Online	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
0.019	0.10	70.846950	0.047997	1.984877	67.811060	0.003623	0.072520	0.072437	0.902434	0.000514	0.006398	0.000001	0.041085	0	0
1.35	0.12	66.389255	0.054726	1.984877	63.354720	0.003421	0.072478	0.072354	0.901405	0.000596	0.007426	0.000001	0.046703	0	0
2.511	0.14	62.165212	0.061837	1.984877	59.132204	0.003211	0.072429	0.072260	0.900231	0.000690	0.008600	0.000001	0.052545	0	0
3.517	0.16	58.154834	0.069301	1.984877	55.123545	0.002994	0.072374	0.072152	0.898891	0.000798	0.009940	0.000001	0.058562	0	0
4.378	0.18	54.342721	0.077087	1.984877	51.313369	0.002774	0.072311	0.072029	0.897361	0.000921	0.011470	0.000001	0.064695	0	0
5.106	0.20	50.716502	0.085170	1.984877	47.689335	0.002551	0.072239	0.071889	0.895612	0.001061	0.013220	0.000001	0.070888	0	0
5.709	0.22	47.265909	0.093527	1.984877	44.241210	0.002328	0.072157	0.071728	0.893609	0.001222	0.015223	0.000002	0.077081	0	0
6.198	0.24	43.982191	0.102144	1.984877	40.960291	0.002107	0.072063	0.071544	0.891310	0.001406	0.017522	0.000002	0.083214	0	0
6.582	0.26	40.857731	0.111021	1.984877	37.839015	0.001891	0.071955	0.071331	0.888662	0.001619	0.020169	0.000002	0.089230	0	0
6.868	0.28	37.885769	0.120171	1.984877	34.870693	0.001681	0.071833	0.071085	0.885601	0.001865	0.023231	0.000003	0.095073	0	0
7.064	0.30	35.060213	0.129632	1.984877	32.049323	0.001478	0.071693	0.070800	0.882042	0.002150	0.026789	0.000003	0.100690	0	0
7.178	0.32	32.375487	0.139475	1.984877	29.369448	0.001286	0.071532	0.070465	0.877878	0.002485	0.030954	0.000003	0.106033	0	0
7.218	0.34	29.826415	0.149814	1.984877	26.826053	0.001105	0.071348	0.070071	0.872960	0.002879	0.035871	0.000004	0.111060	0	0
7.19	0.36	27.408122	0.160832	1.984877	24.414485	0.000937	0.071136	0.069599	0.867087	0.003351	0.041744	0.000004	0.115733	0	0
7.102	0.38	25.115930	0.172817	1.984877	22.130387	0.000783	0.070891	0.069028	0.859964	0.003922	0.048867	0.000005	0.120022	0	0
6.958	0.40	22.945240	0.186233	1.984877	19.969653	0.000643	0.070607	0.068319	0.851142	0.004631	0.057690	0.000006	0.123907	0	0
6.766	0.42	20.891344	0.201869	1.984877	17.928384	0.000518	0.070273	0.067415	0.839876	0.005535	0.068956	0.000007	0.127372	0	0
6.531	0.44	18.949030	0.221195	1.984877	16.002859	0.000409	0.069880	0.066205	0.824801	0.006745	0.084031	0.000008	0.130412	0	0
6.259	0.46	17.111469	0.247453	1.984877	14.189501	0.000315	0.069409	0.064449	0.802918	0.008501	0.105913	0.000009	0.133029	0	0
5.955	0.48	15.365207	0.290635	1.984877	12.484863	0.000235	0.068839	0.061404	0.764988	0.011546	0.143843	0.000011	0.135235	0	0
5.623	0.50	12.938781	1.118842	1.984877	10.885601	0.000170	0.068133	0	0	0.072950	0.908831	0.000013	0.137048	0	0
5.067	0.52	2.132720	10.42826	0.360449	1.704922	0.000118	0.067231	0	0	0.072950	0.908831	0.000015	0.138497	1.624428	7.683538
4.521	0.54	1.407847	9.754807	0.266984	1.074761	0.000078	0.066024	0	0	0.072950	0.908831	0.000018	0.139614	1.717893	6.915500
4.003	0.56	0.993585	8.865739	0.212674	0.716589	0.000048	0.064273	0	0	0.072950	0.908831	0.000023	0.140438	1.772203	5.971293
3.516	0.58	0.719560	7.927664	0.175079	0.483217	0.000027	0.061237	0	0	0.072950	0.908831	0.000031	0.141015	1.809798	4.995039
3.034	0.60	0.469401	6.997209	0.146877	0.322510	0.000014	0	0	0	0.072950	0.908831	0.000199	0.141389	1.838000	4.035840
1.951	0.62	0.231591	4.577614	0.022649	0.208936	0.000006	0	0	0	0.072950	0.908831	0.000199	0.141609	0.337800	3.116225
1.526	0.64	0.142171	3.624221	0.014363	0.127806	0.000002	0	0	0	0.072950	0.908831	0.000199	0.141720	0.252621	2.247900
1.15	0.66	0.079666	2.763763	0.009852	0.069814	0	0	0	0	0.072950	0.908831	0.000199	0.141764	0.202822	1.437196
0.812	0.68	0.035697	1.979239	0.007013	0.028684	0	0	0	0	0.072950	0.908831	0.000199	0.141775	0.168066	0.687418
0.509	0.70	0.005102	1.265532	0.005102	0	0	0	0	0	0.072950	0.908831	0.000199	0.141776	0.141776	0
0.483	0.72	0.003153	1.202070	0.003153	0	0	0	0	0	0.072950	0.908831	0.000199	0.118765	0.101324	0
0.462	0.74	0.001941	1.152214	0.001941	0	0	0	0	0	0.072950	0.908831	0.000199	0.098212	0.072022	0
0.446	0.76	0.001185	1.112669	0.001185	0	0	0	0	0	0.072950	0.908831	0.000199	0.080005	0.050684	0
0.433	0.78	0.000713	1.081169	0.000713	0	0	0	0	0	0.072950	0.908831	0.000199	0.064034	0.035154	0
0.423	0.80	0.000421	1.056084	0.000421	0	0	0	0	0	0.072950	0.908831	0.000199	0.050186	0.023917	0
0.415	0.82	0.000242	1.036195	0.000242	0	0	0	0	0	0.072950	0.908831	0.000199	0.038345	0.015870	0
0.408	0.84	0.000135	1.020569	0.000135	0	0	0	0	0	0.072950	0.908831	0.000199	0.028389	0.010199	0
0.403	0.86	0.000072	1.008465	0.000072	0	0	0	0	0	0.072950	0.908831	0.000199	0.020196	0.006288	0
0.4	0.88	0.000036	0.999288	0.000036	0	0	0	0	0	0.072950	0.908831	0.000199	0.013636	0.003671	0
0.397	0.90	0.000017	0.992542	0.000017	0	0	0	0	0	0.072950	0.908831	0.000199	0.008572	0.001990	0

Table A.3: Consumer Decomposition Scenario α ($p_{O_1} = 0.5, p_{B_2} = 0.7, p_{O_2} = 0.6$)

Profit	Price	Cons. Offline	Cons. Online	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
3E-04	0.10	46.244825	0.001053	25.82954	20.1217251	0.070463	0.151741	0.071352	0	0.0010532	0	0	0	0	0
0.835	0.12	41.747529	0.001213	25.82954	15.6653854	0.030383	0.151025	0.071192	0	0.0012128	0	0	0	0	0
1.501	0.14	37.503713	0.001396	25.82954	11.4428693	0.010112	0.150179	0.071009	0	0.0013959	0	0	0	0	0
2.01	0.16	33.485821	0.001607	25.82954	7.43421047	0.002099	0.149169	0.070798	0	0.0016068	0	0	0	0	0
2.374	0.18	29.672214	0.001851	25.82954	3.62403446	0.000138	0.147943	0.070554	0	0.0018507	0	0	0	0	0
2.605	0.20	26.04624	0.002134	25.82954	0	0	0.146425	0.070271	0	0.0021342	0	0	0	0	0
2.919	0.22	24.319779	0.002466	24.10535	0	0	0.144487	0.069939	0	0.002466	0	0	0	0	0
3.175	0.24	22.674637	0.002858	22.4632	0	0	0.141894	0.069547	0	0.0028578	0	0	0	0	0
3.378	0.26	21.103409	0.003326	20.8962	0	0	0.138129	0.069079	0	0.0033257	0	0	0	0	0
3.529	0.28	19.597495	0.003893	19.39738	0	0	0.131604	0.068512	0	0.0038931	0	0	0	0	0
3.444	0.30	17.214017	0.004596	17.14621	0	0	0	0.067809	0	0.004596	0	0	0	0	0
0.679	0.32	3.0778177	0.005494	3.010906	0	0	0	0.066911	0	0.0054935	0	0	0	0	0
0.51	0.34	2.1173258	0.006695	2.051616	0	0	0	0.06571	0	0.0066946	0	0	0	0	0
0.409	0.36	1.5614257	0.008438	1.497459	0	0	0	0.063967	0	0.0084379	0	0	0	0	0
0.335	0.38	1.1854231	0.01146	1.124478	0	0	0	0.060945	0	0.0114597	0	0	0	0	0
0.279	0.40	0.8562022	0.072405	0.856202	0	0	0	0	0	0.0724048	0	0	0	0	0
0.221	0.42	0.119172	0.609475	0.119172	0	0	0	0	0	0.0724048	0	0	0	0.53707	0
0.176	0.44	0.0678044	0.508689	0.067804	0	0	0	0	0	0.0724048	0	0	0	0.436284	0
0.14	0.46	0.0414561	0.417855	0.041456	0	0	0	0	0	0.0724048	0	0	0	0.345451	0
0.113	0.48	0.0261153	0.342359	0.026115	0	0	0	0	0	0.0724048	0	0	0	0.269955	0
0.091	0.50	0.0166846	0.281193	0.016685	0	0	0	0	0	0.0724048	0	0	0	0.208788	0
0.074	0.52	0.0107212	0.232308	0.010721	0	0	0	0	0	0.0724048	0	0	0	0.159904	0
0.061	0.54	0.0068929	0.19364	0.006893	0	0	0	0	0	0.0724048	0	0	0	0.121235	0
0.051	0.56	0.0044174	0.163342	0.004417	0	0	0	0	0	0.0724048	0	0	0	0.090937	0
0.043	0.58	0.0028135	0.139832	0.002814	0	0	0	0	0	0.0724048	0	0	0	0.067427	0
0.037	0.60	0.0017766	0.121777	0.001777	0	0	0	0	0	0.0724048	0	0	0	0.049372	0
0.033	0.62	0.0011096	0.108066	0.00111	0	0	0	0	0	0.0724048	0	0	0	0.035661	0
0.03	0.64	0.000684	0.097781	0.000684	0	0	0	0	0	0.0724048	0	0	0	0.025376	0
0.027	0.66	0.0004153	0.09017	0.000415	0	0	0	0	0	0.0724048	0	0	0	0.017765	0
0.026	0.68	0.0002478	0.084621	0.000248	0	0	0	0	0	0.0724048	0	0	0	0.012216	0
0.024	0.70	0.0001449	0.08064	0.000145	0	0	0	0	0	0.0724048	0	0	0	0.008235	0
0.023	0.72	8.29E-05	0.077836	8.29E-05	0	0	0	0	0	0.0724048	0	0	0	0.005431	0
0.023	0.74	4.62E-05	0.0759	4.62E-05	0	0	0	0	0	0.0724048	0	0	0	0.003495	0
0.022	0.76	2.50E-05	0.074593	2.50E-05	0	0	0	0	0	0.0724048	0	0	0	0.002188	0
0.022	0.78	1.31E-05	0.073733	1.31E-05	0	0	0	0	0	0.0724048	0	0	0	0.001328	0
0.022	0.80	6.62E-06	0.073182	6.62E-06	0	0	0	0	0	0.0724048	0	0	0	0.000777	0
0.022	0.82	3.20E-06	0.072841	3.20E-06	0	0	0	0	0	0.0724048	0	0	0	0.000437	0
0.022	0.84	1.46E-06	0.072638	1.46E-06	0	0	0	0	0	0.0724048	0	0	0	0.000233	0
0.022	0.86	6.30E-07	0.072522	6.30E-07	0	0	0	0	0	0.0724048	0	0	0	0.000118	0
0.022	0.88	2.51E-07	0.07246	2.51E-07	0	0	0	0	0	0.0724048	0	0	0	5.50E-05	0
0.022	0.90	9.04E-08	0.072428	9.04E-08	0	0	0	0	0	0.0724048	0	0	0	2.34E-05	0

Table A.4: Consumer Decomposition Scenario β ($p_{O_1} = 0.4, p_{B_2} = 0.2, p_{O_2} = 0.3$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.33926	0.18413	0.10001	0.21877	0.15314	0.28996	0.57359	0.17202	0.99980	0.99981	1	0	0.06099	0.02044
1	20	0.32175	0.18145	0.10001	0.21877	0.16553	5.96562	0.75092	3.43008	0.99988	0.99985	1	0	0.52244	0.40738
1	40	0.32249	0.18218	0.10001	0.21877	0.16601	11.82507	0.95019	6.85989	0.99981	0.99984	1	0	1.00822	0.81473
1	60	0.32212	0.18176	0.10001	0.21877	0.16730	17.82855	1.15045	10.28853	0.99970	0.99959	1	0	1.49380	1.22194
1	80	0.31762	0.18278	0.10001	0.21877	0.17125	23.47420	1.33607	13.71920	0.99976	0.99980	1	0	1.97981	1.62939
1	100	0.33928	0.18260	0.10001	0.21877	0.15797	29.40982	1.60162	17.14714	0.99964	0.99949	1	0	2.46551	2.03651
20	1	0.33895	0.19822	0.10001	0.21877	3.07369	0.25855	11.27271	0.18203	0.99982	0.99978	1	0	0.75945	0.02173
20	20	0.33814	0.18479	0.10001	0.21877	3.07774	5.75112	11.45701	3.44011	0.99985	0.99982	1	0	1.21965	0.40868
20	40	0.32587	0.18283	0.10001	0.21877	3.23868	11.75160	11.49721	6.86671	0.99990	0.99985	1	0	1.70430	0.81565
20	60	0.33234	0.18372	0.10001	0.21877	3.15448	17.42690	11.78691	10.29813	0.99986	0.99985	1	0	2.19092	1.22318
20	80	0.32666	0.18247	0.10001	0.21877	3.23159	23.58778	11.90913	13.72598	0.99961	0.99965	1	0	2.67442	1.63030
20	100	0.32766	0.18345	0.10001	0.21877	3.21845	29.12362	12.12223	17.15646	0.99985	0.99983	1	0	3.16158	2.03772
40	1	0.34296	0.23816	0.10001	0.21877	6.07265	0.15902	22.63480	0.22057	0.99940	0.99947	1	0	1.49601	0.02642
40	20	0.34293	0.18370	0.10001	0.21877	6.02848	5.86221	22.83161	3.45325	0.99992	0.99988	1	0	1.95454	0.41036
40	40	0.33814	0.18479	0.10001	0.21877	6.15548	11.50225	22.91402	6.88022	0.99985	0.99982	1	0	2.43930	0.81736
40	60	0.32821	0.18318	0.10001	0.21877	6.41450	17.56478	22.85694	10.30492	0.99988	0.99989	1	0	2.92346	1.22410
40	80	0.32587	0.18283	0.10001	0.21877	6.47736	23.50320	22.99441	13.73342	0.99990	0.99985	1	0	3.40861	1.63129
40	100	0.32941	0.18192	0.10001	0.21877	6.38352	29.70388	23.29467	17.16477	0.99982	0.99981	1	0	3.89496	2.03882
60	1	0.34756	0.26311	0.10001	0.21877	8.95404	0.11902	34.11649	0.26766	0.99964	0.99977	1	0	2.23489	0.03213
60	20	0.33607	0.18315	0.10001	0.21877	9.30791	5.92170	33.88506	3.45892	0.99987	0.99983	1	0	2.68843	0.41114
60	40	0.33451	0.18376	0.10001	0.21877	9.37171	11.67313	34.02779	6.88772	0.99974	0.99985	1	0	3.17280	0.81837
60	60	0.33916	0.18504	0.10001	0.21877	9.19318	17.19856	34.41076	10.32135	0.99987	0.99988	1	0	3.65975	1.22617
60	80	0.33262	0.18398	0.10001	0.21877	9.44828	23.20271	34.35964	13.74553	0.99984	0.99983	1	0	4.14427	1.63284
60	100	0.34195	0.18378	0.10001	0.21877	9.08706	29.07181	34.93323	17.18291	0.99978	0.99972	1	0	4.62930	2.04109
80	1	0.34428	0.26232	0.10001	0.21877	12.09458	0.12962	45.32503	0.27283	0.99916	0.99913	1	0	2.97288	0.03286
80	20	0.34370	0.18614	0.10001	0.21877	12.02318	5.74272	45.49243	3.47771	0.99987	0.99987	1	0	3.42333	0.41349
80	40	0.34293	0.18370	0.10001	0.21877	12.05697	11.72442	45.66322	6.90650	0.99992	0.99988	1	0	3.90909	0.82071
80	60	0.33345	0.18335	0.10001	0.21877	12.55080	17.58262	45.38411	10.32552	0.99984	0.99982	1	0	4.39261	1.22677
80	80	0.33814	0.18479	0.10001	0.21877	12.31095	23.00449	45.82803	13.76044	0.99985	0.99982	1	0	4.87860	1.63473
80	100	0.33209	0.18277	0.10001	0.21877	12.62264	29.44844	45.71962	17.18384	0.99982	0.99985	1	0	5.36276	2.04131
100	1	0.34575	0.26821	0.10001	0.21877	15.03469	0.12033	56.74205	0.29503	0.99928	0.99912	1	0	3.71145	0.03561
100	20	0.33956	0.18515	0.10001	0.21877	15.29240	5.83551	56.55619	3.48351	0.99977	0.99982	1	0	4.15746	0.41429
100	40	0.33835	0.18391	0.10001	0.21877	15.36931	11.71181	56.68454	6.91180	0.99970	0.99980	1	0	4.64193	0.82145
100	60	0.33530	0.18348	0.10001	0.21877	15.56603	17.58408	56.69762	10.33684	0.99988	0.99985	1	0	5.12828	1.22823
100	80	0.33837	0.18425	0.10001	0.21877	15.37036	23.18839	57.09703	13.77086	0.99984	0.99978	1	0	5.61371	1.63608
100	100	0.34254	0.18436	0.10001	0.21877	15.10257	28.92044	57.56954	17.20718	0.99979	0.99982	1	0	6.09880	2.04420

Table A.5: Scenario 1 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.26886	0.21226	0.34649	0.10001	0.26186	0.19059	0.14346	0.60848	0.99991	0.99990	1	0	0.06559	0.03537
1	20	0.38915	0.21161	0.34649	0.10001	0.25580	3.81991	0.22137	11.98871	0.99979	0.99982	1	0	0.50004	0.05468
1	40	0.38819	0.20978	0.34649	0.10001	0.39334	7.75147	0.27836	23.84471	0.99994	0.99992	1	0	0.96421	0.06885
1	60	0.36301	0.21300	0.34649	0.10001	0.54454	11.32262	0.26635	36.05786	0.99990	0.99988	1	0	1.42228	0.06601
1	80	0.27965	0.21307	0.34649	0.10001	0.80155	15.08321	0.19523	48.07443	0.99992	0.99989	1	0	1.84907	0.04860
1	100	0.40205	0.21237	0.34649	0.10001	0.75470	18.96903	0.49276	59.99156	0.99992	0.99988	1	0	2.35911	0.12206
20	1	0.26882	0.21140	0.34649	0.10001	5.10261	0.20860	2.85817	0.77688	0.99980	0.99985	1	0	0.88427	0.70451
20	20	0.27039	0.21485	0.34649	0.10001	5.18896	3.73047	2.86887	12.25107	0.99987	0.99985	1	0	1.31182	0.70726
20	40	0.27251	0.21251	0.34649	0.10001	5.27040	7.59234	2.88187	24.17895	0.99989	0.99988	1	0	1.76253	0.71059
20	60	0.27495	0.21301	0.34649	0.10001	5.33829	11.33443	2.89472	36.22580	0.99985	0.99985	1	0	2.21339	0.71388
20	80	0.28375	0.21338	0.34649	0.10001	5.21883	15.06417	2.91257	48.29315	0.99987	0.99988	1	0	2.66528	0.71840
20	100	0.28307	0.21339	0.34649	0.10001	5.37924	18.82173	2.92568	60.32174	0.99985	0.99985	1	0	3.11716	0.72175
40	1	0.26982	0.21121	0.34649	0.10001	10.13924	0.22586	5.71575	0.95724	0.99979	0.99983	1	0	1.74619	1.40887
40	20	0.26820	0.21194	0.34649	0.10001	10.37149	3.83866	5.72695	12.33729	0.99989	0.99988	1	0	2.17329	1.41175
40	40	0.27039	0.21485	0.34649	0.10001	10.37792	7.46095	5.73775	24.50213	0.99987	0.99985	1	0	2.62364	1.41453
40	60	0.27010	0.21285	0.34649	0.10001	10.54090	11.36520	5.75024	36.38578	0.99986	0.99987	1	0	3.07384	1.41773
40	80	0.27251	0.21251	0.34649	0.10001	10.54079	15.18469	5.76374	48.35791	0.99989	0.99988	1	0	3.52507	1.42117
40	100	0.27478	0.21374	0.34649	0.10001	10.54174	18.78233	5.77593	60.55028	0.99981	0.99983	1	0	3.97603	1.42430
60	1	0.26969	0.21110	0.34649	0.10001	15.21607	0.24458	8.57288	1.13671	0.99967	0.99978	1	0	2.60797	2.11312
60	20	0.27084	0.21348	0.34649	0.10001	15.24804	3.80682	8.58467	12.56895	0.99988	0.99986	1	0	3.03536	2.11614
60	40	0.26939	0.21249	0.34649	0.10001	15.52158	7.62603	8.59626	24.53338	0.99988	0.99988	1	0	3.48538	2.11912
60	60	0.26928	0.21352	0.34649	0.10001	15.66981	11.31693	8.60717	36.62656	0.99990	0.99987	1	0	3.93531	2.12193
60	80	0.27289	0.21222	0.34649	0.10001	15.49307	15.24013	8.62186	48.50266	0.99986	0.99988	1	0	4.38676	2.12567
60	100	0.27246	0.21346	0.34649	0.10001	15.66933	18.83971	8.63239	60.68582	0.99989	0.99983	1	0	4.83688	2.12838
80	1	0.27077	0.21049	0.34649	0.10001	20.15721	0.26475	11.42989	1.31951	0.99960	0.99982	1	0	3.46979	2.81734
80	20	0.26887	0.21148	0.34649	0.10001	20.51972	3.88802	11.44251	12.68111	0.99989	0.99988	1	0	3.89728	2.82056
80	40	0.26820	0.21194	0.34649	0.10001	20.74297	7.67731	11.45390	24.67459	0.99989	0.99988	1	0	4.34657	2.82349
80	60	0.27029	0.21267	0.34649	0.10001	20.63461	11.41369	11.46588	36.73044	0.99989	0.99987	1	0	4.79769	2.82657
80	80	0.27039	0.21485	0.34649	0.10001	20.75584	14.92190	11.47549	49.00426	0.99987	0.99985	1	0	5.24727	2.82906
80	100	0.27165	0.21274	0.34649	0.10001	20.75718	18.97049	11.49026	60.75156	0.99988	0.99986	1	0	5.69803	2.83282
100	1	0.27027	0.21054	0.34649	0.10001	25.27000	0.28020	14.28876	1.49694	0.99984	0.99986	1	0	4.33191	3.52202
100	20	0.26812	0.21335	0.34649	0.10001	25.72394	3.84134	14.29953	12.91552	0.99987	0.99988	1	0	4.75877	3.52479
100	40	0.26781	0.21255	0.34649	0.10001	25.91399	7.65372	14.31134	24.88946	0.99992	0.99990	1	0	5.20844	3.52782
100	60	0.27007	0.21341	0.34649	0.10001	25.71793	11.35898	14.32273	36.97885	0.99986	0.99987	1	0	5.65903	3.53074
100	80	0.26958	0.21394	0.34649	0.10001	25.93051	15.05123	14.33338	49.06908	0.99985	0.99986	1	0	6.10883	3.53349
100	100	0.27028	0.21276	0.34649	0.10001	25.97320	18.98229	14.34686	60.93062	0.99988	0.99984	1	0	6.55904	3.53693

Table A.6: Scenario 2 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.33043	0.18494	0.10001	0.21877	0.15846	0.29814	0.57101	0.17170	0.99989	0.99985	0	1	0.06181	0.02040
1	20	0.33146	0.18322	0.10001	0.21877	0.15778	5.93973	0.82017	3.42971	0.99967	0.99961	0	1	0.53049	0.40734
1	40	0.34055	0.18356	0.10001	0.21877	0.15190	11.82480	1.08889	6.85876	0.99945	0.99941	0	1	1.02363	0.81460
1	60	0.25037	0.18372	0.10001	0.21877	0.24639	17.69371	1.29151	10.28516	0.99879	0.99847	0	1	1.51565	1.22154
1	80	0.30841	0.18324	0.10001	0.21877	0.18337	23.73130	1.60179	13.70514	0.99887	0.99732	0	1	2.00976	1.62772
1	100	0.28799	0.18441	0.10001	0.21877	0.22025	29.24701	1.85638	17.13196	0.99645	0.99672	0	1	2.50298	2.03471
20	1	0.33348	0.27127	0.10001	0.21877	3.15122	0.22875	11.21600	0.24895	0.99978	0.99972	0	1	0.77470	0.02968
20	20	0.33043	0.18494	0.10001	0.21877	3.16926	5.96273	11.42025	3.43394	0.99989	0.99985	0	1	1.23627	0.40795
20	40	0.32782	0.18445	0.10001	0.21877	3.20401	11.84257	11.64996	6.86395	0.99995	0.99989	0	1	1.72959	0.81532
20	60	0.32904	0.18566	0.10001	0.21877	3.18815	17.43433	11.93515	10.29387	0.99996	0.99992	0	1	2.22301	1.22268
20	80	0.32829	0.18403	0.10001	0.21877	3.19749	23.65165	12.18026	13.72357	0.99994	0.99989	0	1	2.71662	1.63001
20	100	0.32819	0.18393	0.10001	0.21877	3.19871	29.56176	12.44103	17.15350	0.99994	0.99991	0	1	3.21012	2.03737
40	1	0.33382	0.27333	0.10001	0.21877	6.29390	0.34220	22.41931	0.26403	0.99986	0.99978	0	1	1.53066	0.03158
40	20	0.33183	0.18511	0.10001	0.21877	6.30095	6.10171	22.61204	3.43794	0.99992	0.99988	0	1	1.97948	0.40854
40	40	0.33043	0.18494	0.10001	0.21877	6.33851	11.92546	22.84049	6.86788	0.99989	0.99985	0	1	2.47255	0.81590
40	60	0.32904	0.18512	0.10001	0.21877	6.37593	17.69797	23.07070	10.29788	0.99992	0.99986	0	1	2.96595	1.22327
40	80	0.32782	0.18445	0.10001	0.21877	6.40802	23.68513	23.29992	13.72789	0.99995	0.99989	0	1	3.45919	1.63064
40	100	0.32849	0.18501	0.10001	0.21877	6.39055	29.33581	23.58517	17.15758	0.99991	0.99986	0	1	3.95280	2.03797
60	1	0.33705	0.28359	0.10001	0.21877	9.31897	0.43082	33.73873	0.28992	0.99980	0.99980	0	1	2.28679	0.03477
60	20	0.32978	0.19201	0.10001	0.21877	9.54496	5.76331	33.71986	3.44373	0.99994	0.99991	0	1	2.72293	0.40933
60	40	0.32961	0.18640	0.10001	0.21877	9.54263	11.86935	33.97073	6.87254	0.99992	0.99989	0	1	3.21566	0.81656
60	60	0.33043	0.18494	0.10001	0.21877	9.50777	17.88819	34.26074	10.30182	0.99989	0.99985	0	1	3.70882	1.22385
60	80	0.32957	0.18438	0.10001	0.21877	9.54100	23.85697	34.48935	13.73166	0.99994	0.99986	0	1	4.20194	1.63120
60	100	0.32810	0.18536	0.10001	0.21877	9.60193	29.36345	34.70453	17.16240	0.99994	0.99992	0	1	4.69534	2.03865
80	1	0.33390	0.28848	0.10001	0.21877	12.58598	0.52877	44.82181	0.31454	0.99991	0.99986	0	1	3.04303	0.03780
80	20	0.33105	0.19025	0.10001	0.21877	12.65420	6.03743	44.92952	3.44742	0.99985	0.99980	0	1	3.46653	0.40989
80	40	0.33183	0.18511	0.10001	0.21877	12.60190	12.20342	45.22409	6.87589	0.99992	0.99988	0	1	3.95895	0.81707
80	60	0.33090	0.18398	0.10001	0.21877	12.64883	18.24354	45.43627	10.30579	0.99993	0.99990	0	1	4.45156	1.22443
80	80	0.33043	0.18494	0.10001	0.21877	12.67702	23.85091	45.68098	13.73576	0.99989	0.99985	0	1	4.94509	1.63180
80	100	0.32873	0.18513	0.10001	0.21877	12.76817	29.59405	45.86128	17.16641	0.99994	0.99991	0	1	5.43804	2.03924
100	1	0.33861	0.28384	0.10001	0.21877	15.43133	0.64769	56.31418	0.31578	0.99979	0.99978	0	1	3.79914	0.03807
100	20	0.33101	0.19350	0.10001	0.21877	15.82889	5.95507	56.09652	3.45291	0.99988	0.99983	0	1	4.21078	0.41065
100	40	0.33357	0.18782	0.10001	0.21877	15.64305	11.97066	56.51748	6.88008	0.99989	0.99986	0	1	4.70247	0.81768
100	60	0.33094	0.18770	0.10001	0.21877	15.81948	17.60447	56.61920	10.31071	0.99989	0.99984	0	1	5.19529	1.22513
100	80	0.33325	0.18603	0.10001	0.21877	15.65938	23.69511	57.02352	13.73946	0.99991	0.99990	0	1	5.68870	1.63235
100	100	0.33043	0.18494	0.10001	0.21877	15.84628	29.81364	57.10123	17.16970	0.99989	0.99985	0	1	6.18136	2.03975

Table A.7: Scenario 3 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.26883	0.22108	0.34649	0.10001	0.25307	0.17634	0.14231	0.62079	0.99987	0.99984	0	1	0.06404	0.03508
1	20	0.27347	0.21833	0.34649	0.10001	0.24762	3.60864	0.14225	12.18515	0.99967	0.99969	0	1	0.46956	0.03518
1	40	0.27585	0.21884	0.34649	0.10001	0.24502	7.18652	0.14227	24.39378	0.99988	0.99984	0	1	0.89659	0.03531
1	60	0.26738	0.21958	0.34649	0.10001	0.26446	10.70842	0.14227	36.65349	0.99958	0.99943	0	1	1.32324	0.03543
1	80	0.27299	0.21879	0.34649	0.10001	0.25389	14.37800	0.14225	48.77309	0.99965	0.99974	0	1	1.75039	0.03555
1	100	0.27716	0.21898	0.34649	0.10001	0.24914	17.94494	0.14225	60.99242	0.99947	0.99935	0	1	2.17711	0.03567
20	1	0.26618	0.20666	0.34649	0.10001	5.13976	0.20080	2.84036	0.74405	0.99990	0.99987	0	1	0.87531	0.70012
20	20	0.26843	0.22263	0.34649	0.10001	5.07387	3.48002	2.84679	12.46261	0.99991	0.99989	0	1	1.28081	0.70182
20	40	0.27093	0.21963	0.34649	0.10001	4.99890	7.14060	2.84571	24.58755	0.99989	0.99983	0	1	1.70736	0.70168
20	60	0.27017	0.21976	0.34649	0.10001	5.02396	10.69756	2.84575	36.81624	0.99989	0.99984	0	1	2.13440	0.70181
20	80	0.27135	0.22049	0.34649	0.10001	4.99015	14.17354	2.84600	49.12612	0.99986	0.99983	0	1	2.56116	0.70199
20	100	0.26968	0.22023	0.34649	0.10001	5.04372	17.75492	2.84580	61.32999	0.99980	0.99985	0	1	2.98857	0.70207
40	1	0.26719	0.20960	0.34649	0.10001	10.21798	0.19822	5.68264	0.90310	0.99975	0.99974	0	1	1.72917	1.40071
40	20	0.26684	0.22169	0.34649	0.10001	10.24325	3.51021	5.69285	12.58988	0.99990	0.99981	0	1	2.13489	1.40334
40	40	0.26843	0.22263	0.34649	0.10001	10.14774	6.96004	5.69358	24.92521	0.99991	0.99989	0	1	2.56162	1.40365
40	60	0.26942	0.22074	0.34649	0.10001	10.08915	10.61105	5.69216	37.05945	0.99989	0.99984	0	1	2.98777	1.40342
40	80	0.27093	0.21963	0.34649	0.10001	9.99781	14.28119	5.69142	49.17509	0.99989	0.99983	0	1	3.41472	1.40336
40	100	0.26659	0.22220	0.34649	0.10001	10.26915	17.45806	5.69326	61.78247	0.99989	0.99985	0	1	3.84212	1.40394
60	1	0.26450	0.23439	0.34649	0.10001	15.57491	0.16666	8.53535	1.11505	0.99845	0.99834	0	1	2.58123	2.10387
60	20	0.26839	0.22248	0.34649	0.10001	15.22075	3.48820	8.53989	12.76935	0.99986	0.99982	0	1	2.98870	2.10510
60	40	0.26658	0.22283	0.34649	0.10001	15.39082	6.94920	8.54041	25.09399	0.99987	0.99983	0	1	3.41510	2.10536
60	60	0.26821	0.21859	0.34649	0.10001	15.23979	10.80810	8.53588	37.01911	0.99989	0.99984	0	1	3.84254	2.10436
60	80	0.26825	0.22203	0.34649	0.10001	15.24087	13.99236	8.53961	49.62075	0.99989	0.99984	0	1	4.26855	2.10540
60	100	0.27157	0.21947	0.34649	0.10001	14.93527	17.87411	8.53711	61.52459	0.99992	0.99988	0	1	4.69605	2.10491
80	1	0.26694	0.19813	0.34649	0.10001	20.45984	0.22949	11.33368	1.18571	0.99904	0.99782	0	1	3.43404	2.79362
80	20	0.26607	0.21113	0.34649	0.10001	20.57463	3.83859	11.36932	12.57164	0.99988	0.99987	0	1	3.84237	2.80252
80	40	0.26684	0.22169	0.34649	0.10001	20.48651	7.02041	11.38571	25.17975	0.99990	0.99981	0	1	4.26978	2.80669
80	60	0.26879	0.21733	0.34649	0.10001	20.24641	10.92560	11.37934	37.05787	0.99989	0.99983	0	1	4.69588	2.80524
80	80	0.26843	0.22263	0.34649	0.10001	20.29549	13.92009	11.38715	49.85042	0.99991	0.99989	0	1	5.12324	2.80729
80	100	0.26767	0.22006	0.34649	0.10001	20.39274	17.78724	11.38324	61.76824	0.99985	0.99978	0	1	5.54882	2.80645
100	1	0.26377	0.20663	0.34649	0.10001	26.06772	0.21297	14.19087	1.36147	0.99937	0.99906	0	1	4.28876	3.49789
100	20	0.26691	0.20957	0.34649	0.10001	25.58905	3.89007	14.20849	12.67495	0.99989	0.99987	0	1	4.69585	3.50234
100	40	0.26818	0.22192	0.34649	0.10001	25.40112	7.00798	14.23230	25.34936	0.99988	0.99987	0	1	5.12368	3.50834
100	60	0.27042	0.22256	0.34649	0.10001	25.05925	10.44967	14.23384	37.69209	0.99991	0.99987	0	1	5.54970	3.50884
100	80	0.26776	0.21945	0.34649	0.10001	25.46820	14.30889	14.22782	49.61813	0.99987	0.99984	0	1	5.97714	3.50748
100	100	0.26825	0.21967	0.34649	0.10001	25.39534	17.84665	14.22848	61.86575	0.99987	0.99984	0	1	6.40461	3.50776

Table A.8: Scenario 4 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.15311	0.28993	0.15306	0	0	0.00005	0.00000	0	0.17497	0.1135798	0	0	0.0013763	0
1	20	0.16551	5.96536	0.16455	0	0	0.00096	0.00000	0	3.50383	2.46052	0	0	0.00101	0
1	40	0.16599	11.82435	0.16407	0	0	0.00193	0.00000	0	7.00528	4.81806	0	0	0.00101	0
1	60	0.16719	17.82726	0.16430	0	0	0.00289	0.00000	0	10.50925	7.31700	0	0	0.00101	0
1	80	0.17122	23.47312	0.16737	0	0	0.00385	0.00000	0	14.00648	9.46575	0	0	0.00089	0
1	100	0.15780	29.40792	0.15299	0	0	0.00481	0.00000	0	17.50805	11.89844	0	0	0.00143	0
20	1	3.07348	0.25818	3.07343	0	0	0.00005	0.00000	0	0.17370	0.06535	0	0	0.01913	0
20	20	3.07715	5.75047	3.07619	0	0	0.00096	0.00000	0	3.49832	2.22567	0	0	0.02647	0
20	40	3.23838	11.75107	3.23646	0	0	0.00193	0.00000	0	7.00320	4.72647	0	0	0.02141	0
20	60	3.15416	17.42578	3.15128	0	0	0.00289	0.00000	0	10.50040	6.90128	0	0	0.02410	0
20	80	3.22955	23.58539	3.22570	0	0	0.00385	0.00000	0	14.00795	9.55538	0	0	0.02206	0
20	100	3.21783	29.12211	3.21302	0	0	0.00481	0.00000	0	17.50280	11.59739	0	0	0.02193	0
40	1	6.07389	0.15503	6.07385	0	0	0.00004	0.00000	0	0.14273	0.00000	0	0	0.01230	0
40	20	6.02822	5.86161	6.02725	0	0	0.00096	0.00000	0	3.50019	2.30172	0	0	0.05970	0
40	40	6.15430	11.50094	6.15238	0	0	0.00192	0.00000	0	6.99665	4.45135	0	0	0.05295	0
40	60	6.41400	17.56324	6.41111	0	0	0.00289	0.00000	0	10.50318	7.01537	0	0	0.04469	0
40	80	6.47676	23.50214	6.47291	0	0	0.00385	0.00000	0	14.00640	9.45293	0	0	0.04281	0
40	100	6.38252	29.70103	6.37770	0	0	0.00481	0.00000	0	17.51519	12.13844	0	0	0.04741	0
60	1	8.95298	0.11839	8.95294	0	0	0.00003	0.00000	0	0.11056	0.00000	0	0	0.00782	0
60	20	9.30716	5.92067	9.30620	0	0	0.00096	0.00000	0	3.50104	2.34041	0	0	0.07922	0
60	40	9.37045	11.67060	9.36852	0	0	0.00192	0.00000	0	7.00012	4.59477	0	0	0.07570	0
60	60	9.19221	17.19743	9.18933	0	0	0.00289	0.00000	0	10.49386	6.62299	0	0	0.08058	0
60	80	9.44730	23.20082	9.44345	0	0	0.00385	0.00000	0	13.99876	9.12980	0	0	0.07226	0
60	100	9.08357	29.06872	9.07876	0	0	0.00481	0.00000	0	17.49949	11.48142	0	0	0.08780	0
80	1	12.09792	0.12090	12.09788	0	0	0.00003	0.00001	0	0.11145	0.00000	0	0	0.00945	0
80	20	12.02241	5.74155	12.02145	0	0	0.00096	0.00000	0	3.49609	2.13092	0	0	0.11454	0
80	40	12.05643	11.72323	12.05451	0	0	0.00192	0.00000	0	7.00038	4.60345	0	0	0.11940	0
80	60	12.54865	17.58075	12.54577	0	0	0.00289	0.00000	0	10.50212	6.97902	0	0	0.09961	0
80	80	12.30861	23.00188	12.30476	0	0	0.00385	0.00000	0	13.99329	8.90270	0	0	0.10590	0
80	100	12.62101	29.44416	12.61620	0	0	0.00481	0.00000	0	17.50847	11.83743	0	0	0.09825	0
100	1	15.03522	0.11402	15.03518	0	0	0.00003	0.00001	0	0.10460	0.00000	0	0	0.00943	0
100	20	15.29070	5.83332	15.28974	0	0	0.00096	0.00000	0	3.49772	2.20040	0	0	0.13520	0
100	40	15.36615	11.70957	15.36422	0	0	0.00192	0.00000	0	6.99953	4.57400	0	0	0.13605	0
100	60	15.56503	17.58184	15.56214	0	0	0.00289	0.00000	0	10.50155	6.95141	0	0	0.12888	0
100	80	15.36790	23.18588	15.36405	0	0	0.00385	0.00000	0	13.99676	9.05438	0	0	0.13474	0
100	100	15.10011	28.91748	15.09530	0	0	0.00481	0.00000	0	17.49512	11.27630	0	0	0.14606	0

Table A.9: Consumer Drift Scenario 1 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.26184	0.19058	0.14997	0.10474	0	0.00706	0.00007	0	0.18976	0	0	0.00077	0.00003	0.00002
1	20	0.25597	3.81937	0.12351	0.00000	0	0.13246	0.00000	0	3.81687	0	0	0.00066	0.00184	0.00000
1	40	0.39335	7.75115	0.12400	0.00000	0	0.26936	0.00000	0	7.74858	0	0	0.00070	0.00188	0.00000
1	60	0.54454	11.32163	0.13902	0.00000	0	0.40552	0.00000	0	11.31983	0	0	0.00071	0.00110	0.00000
1	80	0.80146	15.08225	0.14995	0.08889	0	0.55968	0.00294	0	15.08141	0	0	0.00076	0.00005	0.00003
1	100	0.75506	18.96824	0.11620	0.00000	0	0.63886	0.00000	0	18.96542	0	0	0.00061	0.00221	0.00000
20	1	5.10238	0.20795	2.99936	2.09585	0	0.00711	0.00007	0	0.19111	0	0	0.01586	0.00057	0.00040
20	20	5.18831	3.72970	2.99943	2.04932	0	0.13811	0.00146	0	3.71448	0	0	0.01438	0.00050	0.00034
20	40	5.26966	7.59161	2.99925	1.98661	0	0.28152	0.00227	0	7.57510	0	0	0.01538	0.00068	0.00045
20	60	5.33722	11.33283	2.99916	1.91469	0	0.42037	0.00300	0	11.31640	0	0	0.01516	0.00077	0.00049
20	80	5.21817	15.06130	2.99865	1.65948	0	0.55781	0.00223	0	15.04431	0	0	0.01501	0.00128	0.00071
20	100	5.37801	18.81930	2.99870	1.67912	0	0.69725	0.00294	0	18.80239	0	0	0.01499	0.00123	0.00069
40	1	10.13853	0.22540	5.99862	4.13273	0	0.00712	0.00006	0	0.19141	0	0	0.03189	0.00124	0.00086
40	20	10.37065	3.83798	5.99881	4.22889	0	0.14152	0.00143	0	3.80493	0	0	0.03125	0.00105	0.00074
40	40	10.37663	7.45941	5.99886	4.09863	0	0.27622	0.00291	0	7.42895	0	0	0.02877	0.00100	0.00069
40	60	10.53986	11.36289	5.99873	4.11582	0	0.42129	0.00402	0	11.33052	0	0	0.03046	0.00113	0.00078
40	80	10.53932	15.18321	5.99850	3.97322	0	0.56305	0.00455	0	15.15019	0	0	0.03076	0.00136	0.00090
40	100	10.53991	18.77907	5.99840	3.83981	0	0.69642	0.00527	0	18.74698	0	0	0.02969	0.00146	0.00093
60	1	15.21534	0.24270	8.99793	6.21023	0	0.00712	0.00006	0	0.19158	0	0	0.04797	0.00187	0.00129
60	20	15.24684	3.80491	8.99808	6.10776	0	0.13968	0.00132	0	3.75716	0	0	0.04488	0.00171	0.00116
60	40	15.52011	7.62489	8.99814	6.23751	0	0.28173	0.00274	0	7.57592	0	0	0.04616	0.00166	0.00115
60	60	15.66841	11.31441	8.99827	6.24678	0	0.41900	0.00436	0	11.26699	0	0	0.04483	0.00153	0.00106
60	80	15.49208	15.23643	8.99766	5.92571	0	0.56435	0.00437	0	15.18638	0	0	0.04651	0.00214	0.00141
60	100	15.66675	18.83727	8.99788	5.96455	0	0.69831	0.00601	0	18.78920	0	0	0.04489	0.00191	0.00127
80	1	20.15608	0.26229	11.99693	8.15194	0	0.00716	0.00006	0	0.19254	0	0	0.06506	0.00279	0.00190
80	20	20.51855	3.88690	11.99744	8.37771	0	0.14205	0.00134	0	3.81969	0	0	0.06333	0.00228	0.00159
80	40	20.74130	7.67596	11.99761	8.45777	0	0.28305	0.00286	0	7.60986	0	0	0.06250	0.00211	0.00149
80	60	20.63261	11.41229	11.99740	8.20937	0	0.42190	0.00394	0	11.34716	0	0	0.06123	0.00232	0.00159
80	80	20.75325	14.91881	11.99772	8.19727	0	0.55244	0.00583	0	14.85791	0	0	0.05753	0.00201	0.00137
80	100	20.75441	18.96686	11.99719	8.04857	0	0.70259	0.00607	0	18.90152	0	0	0.06111	0.00253	0.00170
100	1	25.26827	0.27933	14.99631	10.26474	0	0.00716	0.00006	0	0.19246	0	0	0.08124	0.00334	0.00229
100	20	25.72265	3.84022	14.99728	10.58393	0	0.13990	0.00154	0	3.76107	0	0	0.07509	0.00237	0.00168
100	40	25.91246	7.65254	14.99720	10.63059	0	0.28165	0.00302	0	7.57154	0	0	0.07680	0.00245	0.00174
100	60	25.71515	11.35691	14.99694	10.29474	0	0.41933	0.00414	0	11.27739	0	0	0.07494	0.00271	0.00186
100	80	25.92739	15.04908	14.99713	10.36770	0	0.55672	0.00583	0	14.97098	0	0	0.07383	0.00253	0.00175
100	100	25.96963	18.97935	14.99678	10.26360	0	0.70265	0.00660	0	18.89816	0	0	0.07634	0.00288	0.00197

Table A.10: Consumer Drift Scenario 2 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.15846	0.29811	0.15846	0	0	0.00000	0.00000	0	0.17981	0.11075	0	0.00643	0.00112	0
1	20	0.15771	5.93922	0.15771	0	0	0.00000	0.00000	0	3.59624	2.33538	0	0.00641	0.00120	0
1	40	0.15166	11.82342	0.15166	0	0	0.00000	0.00000	0	7.19248	4.62333	0	0.00618	0.00143	0
1	60	0.23345	17.69592	0.21638	0	0	0.01356	0.00214	0.00137	10.78659	6.90056	0	0.00870	0.00008	0
1	80	0.17383	23.73000	0.17349	0	0	0.00034	0.00000	0	14.38497	9.33734	0	0.00701	0.00069	0
1	100	0.19086	29.25032	0.18802	0	0	0.00275	0.00005	0.00003	17.98115	11.26122	0	0.00757	0.00038	0
20	1	3.15120	0.22887	3.15117	0	0	0.00000	0.00003	0	0.11103	0.00000	0	0.11701	0.00083	0
20	20	3.16910	5.96220	3.16910	0	0	0.00000	0.00000	0	3.59624	2.21502	0	0.12858	0.02235	0
20	40	3.20396	11.84184	3.20395	0	0	0.00001	0.00000	0	7.19248	4.49805	0	0.12994	0.02136	0
20	60	3.18811	17.43340	3.18810	0	0	0.00001	0.00000	0	10.78872	6.49415	0	0.12926	0.02127	0
20	80	3.19742	23.65031	3.19741	0	0	0.00001	0.00000	0	14.38497	9.11380	0	0.12972	0.02183	0
20	100	3.19867	29.56008	3.19865	0	0	0.00001	0.00000	0	17.98121	11.42726	0	0.12977	0.02184	0
40	1	6.29377	0.34269	6.29374	0	0	0.00000	0.00003	0	0.10877	0.00000	0	0.23245	0.00147	0
40	20	6.30081	6.10105	6.30081	0	0	0.00000	0.00000	0	3.59624	2.20322	0	0.25572	0.04587	0
40	40	6.33821	11.92439	6.33820	0	0	0.00000	0.00000	0	7.19248	4.43004	0	0.25716	0.04470	0
40	60	6.37569	17.69691	6.37568	0	0	0.00001	0.00000	0	10.78872	6.60648	0	0.25856	0.04314	0
40	80	6.40792	23.68367	6.40790	0	0	0.00001	0.00000	0	14.38497	8.99610	0	0.25988	0.04272	0
40	100	6.39030	29.33431	6.39029	0	0	0.00001	0.00000	0	17.98121	11.05121	0	0.25913	0.04276	0
60	1	9.31762	0.43108	9.31757	0	0	0.00000	0.00004	0	0.09801	0.00000	0	0.33173	0.00134	0
60	20	9.54483	5.76253	9.54483	0	0	0.00000	0.00000	0	3.59624	1.72585	0	0.38571	0.05474	0
60	40	9.54254	11.86779	9.54254	0	0	0.00000	0.00000	0	7.19248	4.22514	0	0.38679	0.06339	0
60	60	9.50731	17.88659	9.50730	0	0	0.00000	0.00000	0	10.78872	6.64507	0	0.38575	0.06705	0
60	80	9.54075	23.85483	9.54074	0	0	0.00001	0.00000	0	14.38497	9.01600	0	0.38713	0.06674	0
60	100	9.60180	29.36143	9.60179	0	0	0.00001	0.00000	0	17.98121	10.92797	0	0.38925	0.06300	0
80	1	12.58545	0.52955	12.58538	0	0	0.00000	0.00006	0	0.09313	0.00000	0	0.43548	0.00094	0
80	20	12.65450	6.03340	12.65450	0	0	0.00000	0.00000	0	3.59624	1.84625	0	0.51204	0.07887	0
80	40	12.60162	12.20209	12.60161	0	0	0.00000	0.00000	0	7.19248	4.40644	0	0.51144	0.09173	0
80	60	12.64858	18.24211	12.64858	0	0	0.00000	0.00000	0	10.78872	6.84729	0	0.51353	0.09256	0
80	80	12.67641	23.84879	12.67641	0	0	0.00001	0.00000	0	14.38497	8.86009	0	0.51433	0.08940	0
80	100	12.76804	29.59104	12.76803	0	0	0.00001	0.00000	0	17.98121	11.00640	0	0.51776	0.08568	0
100	1	15.42943	0.64895	15.42939	0	0	0.00000	0.00004	0	0.09776	0.00000	0	0.54875	0.00244	0
100	20	15.82907	5.95023	15.82907	0	0	0.00000	0.00000	0	3.59624	1.62448	0	0.63932	0.09019	0
100	40	15.64301	11.96648	15.64301	0	0	0.00000	0.00000	0	7.19248	4.02865	0	0.63424	0.11110	0
100	60	15.81886	17.60218	15.81885	0	0	0.00000	0.00000	0	10.78872	6.06732	0	0.64096	0.10518	0
100	80	15.65912	23.69165	15.65912	0	0	0.00000	0.00000	0	14.38497	8.55570	0	0.63547	0.11552	0
100	100	15.84551	29.81098	15.84551	0	0	0.00001	0.00000	0	17.98121	11.07511	0	0.64291	0.11175	0

Table A.11: Consumer Drift Scenario 3 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.25305	0.17630	0.14815	0.10479	0	0	0.00011	0	0.17623	0	0	0.00005	0.00001	0.00001
1	20	0.24732	3.60818	0.14795	0.09792	0	0	0.00145	0	3.60810	0	0	0.00005	0.00002	0.00002
1	40	0.24487	7.18532	0.14784	0.09444	0	0	0.00259	0	7.18523	0	0	0.00005	0.00003	0.00002
1	60	0.26161	10.70851	0.14820	0.10695	0	0	0.00645	0	10.70844	0	0	0.00005	0.00001	0.00001
1	80	0.25269	14.37574	0.14797	0.09863	0	0	0.00609	0	14.37566	0	0	0.00005	0.00002	0.00002
1	100	0.24635	17.94356	0.14777	0.09251	0	0	0.00606	0	17.94346	0	0	0.00005	0.00003	0.00002
20	1	5.13961	0.20068	2.96478	2.17476	0	0	0.00006	0	0.19863	0	0	0.00091	0.00065	0.00048
20	20	5.07351	3.47951	2.96345	2.10776	0	0	0.00230	0	3.47821	0	0	0.00091	0.00023	0.00016
20	40	4.99840	7.13850	2.96129	2.03356	0	0	0.00355	0	7.13698	0	0	0.00091	0.00036	0.00025
20	60	5.02347	10.69427	2.96193	2.05596	0	0	0.00558	0	10.69279	0	0	0.00091	0.00034	0.00023
20	80	4.98938	14.17090	2.96094	2.02122	0	0	0.00722	0	14.16940	0	0	0.00091	0.00035	0.00024
20	100	5.04255	17.75265	2.96231	2.07051	0	0	0.00974	0	17.75121	0	0	0.00091	0.00031	0.00022
40	1	10.21744	0.19774	5.92803	4.28934	0	0	0.00007	0	0.19394	0	0	0.00183	0.00115	0.00083
40	20	10.24266	3.50862	5.92942	4.31084	0	0	0.00240	0	3.50604	0	0	0.00183	0.00043	0.00032
40	40	10.14703	6.95903	5.92690	4.21552	0	0	0.00461	0	6.95641	0	0	0.00183	0.00046	0.00033
40	60	10.08805	10.60666	5.92518	4.15680	0	0	0.00607	0	10.60384	0	0	0.00183	0.00059	0.00041
40	80	9.99680	14.27700	5.92258	4.06712	0	0	0.00710	0	14.27396	0	0	0.00183	0.00072	0.00050
40	100	10.26761	17.45649	5.92982	4.32539	0	0	0.01241	0	17.45396	0	0	0.00183	0.00041	0.00030
60	1	15.57559	0.15987	8.89812	6.67725	0	0	0.00022	0	0.15690	0	0	0.00274	0.00013	0.00010
60	20	15.21988	3.48657	8.89037	6.32721	0	0	0.00230	0	3.48263	0	0	0.00274	0.00070	0.00050
60	40	15.38916	6.94735	8.89477	6.48929	0	0	0.00510	0	6.94362	0	0	0.00274	0.00057	0.00042
60	60	15.23907	10.80280	8.89058	6.34261	0	0	0.00588	0	10.79843	0	0	0.00274	0.00095	0.00068
60	80	15.23945	13.98746	8.89073	6.33964	0	0	0.00908	0	13.98349	0	0	0.00274	0.00071	0.00051
60	100	14.93453	17.87146	8.88224	6.04378	0	0	0.00850	0	17.86678	0	0	0.00274	0.00115	0.00078
80	1	20.45999	0.22420	11.85325	8.60671	0	0	0.00004	0	0.21260	0	0	0.00366	0.00460	0.00334
80	20	20.57416	3.83720	11.86013	8.71248	0	0	0.00155	0	3.83024	0	0	0.00366	0.00190	0.00139
80	40	20.48532	7.01724	11.85884	8.62167	0	0	0.00481	0	7.01208	0	0	0.00366	0.00087	0.00063
80	60	20.24496	10.92041	11.85206	8.38751	0	0	0.00538	0	10.91426	0	0	0.00366	0.00146	0.00103
80	80	20.29405	13.91805	11.85380	8.43104	0	0	0.00922	0	13.91282	0	0	0.00366	0.00092	0.00065
80	100	20.38911	17.78105	11.85596	8.52240	0	0	0.01076	0	17.77555	0	0	0.00366	0.00107	0.00077
100	1	26.06893	0.20812	14.83236	11.23650	0	0	0.00007	0	0.19866	0	0	0.00457	0.00278	0.00211
100	20	25.58814	3.88902	14.82153	10.76524	0	0	0.00137	0	3.87960	0	0	0.00457	0.00281	0.00204
100	40	25.39968	7.00502	14.81815	10.57700	0	0	0.00453	0	6.99840	0	0	0.00457	0.00120	0.00085
100	60	25.05832	10.44768	14.80901	10.24307	0	0	0.00623	0	10.44079	0	0	0.00457	0.00137	0.00095
100	80	25.46663	14.30124	14.81953	10.63876	0	0	0.00833	0	14.29423	0	0	0.00457	0.00142	0.00102
100	100	25.39345	17.84135	14.81758	10.56562	0	0	0.01025	0	17.83429	0	0	0.00457	0.00145	0.00104

Table A.12: Consumer Drift Scenario 4 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 0, \xi_{O_2} = 1$)

A.2 Clothes

Price Offline	Consumer Offline	Consumer Online	Elasticity	Profit F_1	Profit F_2
0.1	49.25957	0.00488	-0.53850	0.00195	0.00082
0.12	44.11296	0.00555	-0.63938	0.88448	0.00093
0.14	39.54314	0.00624	-0.74316	1.58422	0.00104
0.16	35.45615	0.00696	-0.85051	2.13015	0.00116
0.18	31.78280	0.00769	-0.96204	2.54570	0.00128
0.2	28.46980	0.00842	-1.07832	2.85035	0.00141
0.22	25.47468	0.00916	-1.19994	3.06063	0.00153
0.24	22.76268	0.00989	-1.32753	3.19073	0.00165
0.26	20.30474	0.01060	-1.46177	3.25300	0.00177
0.28	18.07611	0.01130	-1.60340	3.25822	0.00189
0.3	16.05541	0.01197	-1.75327	3.21587	0.00200
0.32	14.22392	0.01260	-1.91233	3.13430	0.00210
0.34	12.56512	0.01320	-2.08169	3.02091	0.00220
0.36	11.06426	0.01375	-2.26264	2.88221	0.00230
0.38	9.70807	0.01426	-2.45672	2.72397	0.00238
0.4	8.48457	0.01473	-2.66575	2.55126	0.00246
0.42	7.38283	0.01514	-2.89198	2.36856	0.00253
0.44	6.39288	0.01550	-3.13813	2.17978	0.00259
0.46	5.50556	0.01581	-3.40765	1.98832	0.00264
0.48	4.71240	0.01607	-3.70494	1.79714	0.00268
0.5	4.00559	0.01629	-38.79302	1.60875	0.00272
0.52	0.62349	2.77086	-13.42067	1.37021	0.00275
0.54	0.35334	2.48581	-12.08771	1.14979	0.00277
0.56	0.21488	2.13514	-11.87472	0.95290	0.00279
0.58	0.13382	1.78728	-12.10541	0.77915	0.00280
0.6	0.08376	1.46319	-20.86405	0.62716	0.00281
0.62	0.04104	0.92589	-15.81985	0.39170	0.00833
0.64	0.02240	0.64631	-18.21010	0.27062	0.00752
0.66	0.01106	0.40812	-22.96800	0.16944	0.00672
0.68	0.00425	0.20518	-36.06120	0.08454	0.00603
0.7	0.00030	0.03370	-20.88529	0.01366	0.00544
0.72	0.00015	0.02336	-21.69204	0.00944	0.07554
0.74	0.00007	0.01616	-22.68786	0.00651	0.13330
0.76	0.00003	0.01109	-23.87484	0.00446	0.18020
0.78	0.00002	0.00752	-25.27061	0.00302	0.21765
0.8	0.00001	0.00499	-26.90754	0.00200	0.24696
0.82	0.00000	0.00322	-28.83604	0.00129	0.26936
0.84	0.00000	0.00201	-31.13218	0.00080	0.28599
0.86	0.00000	0.00119	-33.91252	0.00048	0.29790
0.88	0.00000	0.00066	-37.36225	0.00026	0.30604
0.9	0.00000	0.00033	-0.53850	0.00013	0.31127

Table A.13: Elasticity Scenario α ($p_{O_1} = 0.5, p_{B_2} = 0.7, p_{O_2} = 0.6$)

Price Offline	Consumer Offline	Consumer Online	Elasticity	Profit F_1	Profit F_2
0.1	35.22049	0.00000	-0.75679	0.00000	1.44138
0.12	30.05156	0.00000	-0.94125	0.60103	1.44361
0.14	25.47046	0.00000	-1.15533	1.01882	1.44474
0.16	21.37902	0.00000	-1.41113	1.28274	1.44518
0.18	17.70459	0.00000	-1.72709	1.41637	1.44529
0.2	14.39152	0.00000	-1.06658	1.43915	1.44530
0.22	12.89390	0.00000	-1.18579	1.54727	1.59506
0.24	11.53704	0.00000	-1.31205	1.61519	1.73075
0.26	10.30498	0.00000	-1.44731	1.64880	1.85396
0.28	9.18389	0.00000	-1.59355	1.65310	1.96607
0.3	8.02691	0.00000	-22.99687	1.60538	2.09526
0.32	1.33442	0.00000	-7.62202	0.29357	3.33737
0.34	0.79847	0.00000	-6.82279	0.19163	3.35731
0.36	0.51590	0.00000	-6.68115	0.13413	3.33362
0.38	0.34396	0.00000	-6.77837	0.09631	3.29439
0.4	0.23276	0.00000	-31.95469	0.06983	3.24931
0.42	0.02926	0.12928	-13.88098	0.04815	2.62948
0.44	0.01354	0.09459	-13.04538	0.03298	2.62534
0.46	0.00678	0.06681	-13.01546	0.02248	2.64155
0.48	0.00350	0.04634	-13.29247	0.01523	2.66428
0.5	0.00183	0.03168	-13.74113	0.01024	2.68887
0.52	0.00096	0.02138	-14.30912	0.00682	2.71325
0.54	0.00051	0.01423	-14.97277	0.00449	2.73641
0.56	0.00026	0.00934	-15.72094	0.00292	2.75782
0.58	0.00014	0.00603	-16.54899	0.00188	2.77725
0.6	0.00007	0.00383	-17.45617	0.00118	2.79463
0.62	0.00003	0.00239	-18.44446	0.00074	2.81000
0.64	0.00002	0.00146	-19.51801	0.00045	2.82342
0.66	0.00001	0.00088	-20.68297	0.00027	2.83503
0.68	0.00000	0.00051	-21.94755	0.00016	2.84495
0.7	0.00000	0.00029	-23.32227	0.00009	2.85334
0.72	0.00000	0.00016	-24.82043	0.00005	2.86036
0.74	0.00000	0.00009	-26.45880	0.00003	2.86614
0.76	0.00000	0.00005	-28.25873	0.00001	2.87083
0.78	0.00000	0.00002	-30.24774	0.00001	2.87458
0.8	0.00000	0.00001	-32.46205	0.00000	2.87751
0.82	0.00000	0.00001	-34.95055	0.00000	2.87975
0.84	0.00000	0.00000	-37.78136	0.00000	2.88142
0.86	0.00000	0.00000	-41.05330	0.00000	2.88261
0.88	0.00000	0.00000	-44.91682	0.00000	2.88342
0.9	0.00000	0.00000	-0.75679	0.00000	2.88394

Table A.14: Elasticity Scenario β ($p_{O_1} = 0.4, p_{B_2} = 0.2, p_{O_2} = 0.3$)

Profit	Price	Cons. Offline	Cons. Online	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
0.002	0.1	49.2596	0.0048828	0.31337672	48.94597	0.0002163	1.98E-10	1.98E-10	9.32E-07	2.73E-13	1.28E-09	1.98E-16	0.0048828	0	0
0.884	0.12	44.113	0.0055503	0.31337672	43.79938	0.0002043	1.98E-10	1.98E-10	9.32E-07	3.48E-13	1.64E-09	2.62E-16	0.0055503	0	0
1.584	0.14	39.5431	0.0062447	0.31337672	39.22957	0.0001917	1.98E-10	1.98E-10	9.32E-07	4.43E-13	2.08E-09	3.43E-16	0.0062447	0	0
2.13	0.16	35.4562	0.0069597	0.31337672	35.1426	0.0001788	1.98E-10	1.98E-10	9.31E-07	5.61E-13	2.64E-09	4.47E-16	0.0069597	0	0
2.546	0.18	31.7828	0.0076886	0.31337672	31.46926	0.0001656	1.98E-10	1.98E-10	9.30E-07	7.07E-13	3.32E-09	5.78E-16	0.0076886	0	0
2.85	0.2	28.4698	0.0084246	0.31337672	28.15627	0.0001523	1.98E-10	1.98E-10	9.30E-07	8.89E-13	4.18E-09	7.44E-16	0.0084246	0	0
3.061	0.22	25.4747	0.0091606	0.31337672	25.16116	0.000139	1.98E-10	1.98E-10	9.28E-07	1.11E-12	5.24E-09	9.50E-16	0.0091606	0	0
3.191	0.24	22.7627	0.0098895	0.31337672	22.44918	0.0001258	1.98E-10	1.97E-10	9.27E-07	1.39E-12	6.55E-09	1.21E-15	0.0098895	0	0
3.253	0.26	20.3047	0.0106045	0.31337672	19.99125	0.0001129	1.98E-10	1.97E-10	9.26E-07	1.74E-12	8.18E-09	1.53E-15	0.0106045	0	0
3.258	0.28	18.0761	0.0112989	0.31337672	17.76263	0.0001003	1.97E-10	1.97E-10	9.24E-07	2.17E-12	1.02E-08	1.93E-15	0.0112989	0	0
3.216	0.3	16.0554	0.0119665	0.31337672	15.74194	8.83E-05	1.97E-10	1.96E-10	9.21E-07	2.71E-12	1.27E-08	2.43E-15	0.0119665	0	0
3.134	0.32	14.2239	0.0126015	0.31337672	13.91047	7.68E-05	1.97E-10	1.95E-10	9.18E-07	3.38E-12	1.59E-08	3.04E-15	0.0126015	0	0
3.021	0.34	12.5651	0.0131988	0.31337672	12.25168	6.60E-05	1.97E-10	1.94E-10	9.14E-07	4.23E-12	1.99E-08	3.80E-15	0.0131988	0	0
2.882	0.36	11.0643	0.0137542	0.31337672	10.75082	5.60E-05	1.96E-10	1.93E-10	9.09E-07	5.32E-12	2.50E-08	4.75E-15	0.0137542	0	0
2.724	0.38	9.70807	0.014264	0.31337672	9.394645	4.67E-05	1.96E-10	1.92E-10	9.02E-07	6.71E-12	3.16E-08	5.92E-15	0.014264	0	0
2.551	0.4	8.48457	0.0147257	0.31337672	8.171151	3.84E-05	1.95E-10	1.90E-10	8.94E-07	8.56E-12	4.02E-08	7.39E-15	0.0147256	0	0
2.369	0.42	7.38283	0.0151375	0.31337672	7.069424	3.09E-05	1.95E-10	1.88E-10	8.82E-07	1.11E-11	5.19E-08	9.23E-15	0.0151374	0	0
2.18	0.44	6.39288	0.0154987	0.31337672	6.079482	2.44E-05	1.94E-10	1.84E-10	8.65E-07	1.46E-11	6.85E-08	1.15E-14	0.0154987	0	0
1.988	0.46	5.50556	0.0158098	0.31337672	5.19216	1.88E-05	1.93E-10	1.79E-10	8.40E-07	2.00E-11	9.40E-08	1.45E-14	0.0158097	0	0
1.797	0.48	4.7124	0.016072	0.31337672	4.399004	1.41E-05	1.91E-10	1.69E-10	7.93E-07	2.98E-11	1.40E-07	1.83E-14	0.0160719	0	0
1.609	0.5	4.00559	0.0162883	0.31337672	3.692202	1.02E-05	1.90E-10	0	0	1.99E-10	9.34E-07	2.33E-14	0.0162874	0	0
1.37	0.52	0.62349	2.770861	0.05784225	0.565638	7.05E-06	1.87E-10	0	0	1.99E-10	9.34E-07	3.01E-14	0.0164595	0.255534	2.498866
1.15	0.54	0.35334	2.4858131	0.03922923	0.314105	4.65E-06	1.84E-10	0	0	1.99E-10	9.34E-07	3.98E-14	0.0165923	0.274147	2.195072
0.953	0.56	0.21488	2.1351387	0.02885903	0.186018	2.87E-06	1.78E-10	0	0	1.99E-10	9.34E-07	5.45E-14	0.0166903	0.284518	1.83393
0.779	0.58	0.13382	1.7872843	0.02202111	0.111798	1.64E-06	1.68E-10	0	0	1.99E-10	9.34E-07	8.14E-14	0.0167588	0.291356	1.479169
0.627	0.6	0.08376	1.4631938	0.01715385	0.066605	8.31E-07	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0168033	0.296223	1.150167
0.392	0.62	0.04104	0.9258917	0.00249831	0.038538	3.58E-07	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0168294	0.055344	0.853717
0.271	0.64	0.0224	0.6463144	0.0013482	0.021055	1.19E-07	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0168426	0.037881	0.59159
0.169	0.66	0.01106	0.4081174	0.0007935	0.010269	2.48E-08	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0168479	0.028066	0.363203
0.085	0.68	0.00425	0.2051792	0.00048611	0.003765	1.63E-09	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0168491	0.021535	0.166794
0.014	0.7	0.0003	0.0336994	0.00030462	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0168492	0.016849	0
0.009	0.72	0.00015	0.0233587	0.00014972	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0130357	0.010322	0
0.007	0.74	7.28E-05	0.0161592	7.28E-05	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0099022	0.006256	0
0.004	0.76	3.48E-05	0.0110938	3.48E-05	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0073636	0.003729	0
0.003	0.78	1.63E-05	0.0075151	1.63E-05	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0053404	0.002174	0
0.002	0.8	7.38E-06	0.004991	7.38E-06	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0037592	0.001231	0
0.001	0.82	3.21E-06	0.003225	3.21E-06	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0025522	0.000672	0
8E-04	0.84	1.33E-06	0.0020079	1.33E-06	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0016569	0.00035	0
5E-04	0.86	5.18E-07	0.0011891	5.18E-07	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0010163	0.000172	0
3E-04	0.88	1.86E-07	0.0006576	1.86E-07	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0005787	7.80E-05	0
1E-04	0.9	5.95E-08	0.0003304	5.95E-08	0	0	0	0	0	1.99E-10	9.34E-07	5.42E-13	0.0002977	3.18E-05	0

Table A.15: Consumer Decomposition Scenario α ($p_{O_1} = 0.5, p_{B_2} = 0.7, p_{O_2} = 0.6$)

Profit	Price	Cons. Offline	Cons. Online	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
6E-05	0.1	35.2205	0.000216	14.3915115	20.7897	0.03926	9.18E-06	2.92E-06	0	1.31E-08	0	0	0	0	0
0.601	0.12	30.0516	0.000216	14.3915115	15.64311	0.0169284	9.15E-06	2.92E-06	0	1.65E-08	0	0	0	0	0
1.019	0.14	25.4705	0.000216	14.3915115	11.0733	0.0056342	9.11E-06	2.92E-06	0	2.06E-08	0	0	0	0	0
1.283	0.16	21.379	0.000216	14.3915115	6.986329	0.0011698	9.06E-06	2.91E-06	0	2.57E-08	0	0	0	0	0
1.416	0.18	17.7046	0.000216	14.3915115	3.312992	7.68E-05	8.99E-06	2.90E-06	0	3.21E-08	0	0	0	0	0
1.439	0.2	14.3915	0.000216	14.3915115	0	0	8.90E-06	2.90E-06	0	4.00E-08	0	0	0	0	0
1.547	0.22	12.8939	0.000216	12.8938878	0	0	8.79E-06	2.89E-06	0	5.00E-08	0	0	0	0	0
1.615	0.24	11.537	0.000216	11.5370273	0	0	8.62E-06	2.87E-06	0	6.26E-08	0	0	0	0	0
1.649	0.26	10.305	0.000216	10.3049664	0	0	8.37E-06	2.86E-06	0	7.86E-08	0	0	0	0	0
1.653	0.28	9.18389	0.000216	9.18387805	0	0	7.91E-06	2.84E-06	0	9.92E-08	0	0	0	0	0
1.605	0.3	8.02691	0.000216	8.02690306	0	0	0	2.81E-06	0	1.26E-07	0	0	0	0	0
0.294	0.32	1.33442	0.000216	1.33441758	0	0	0	2.77E-06	0	1.63E-07	0	0	0	0	0
0.192	0.34	0.79847	0.000216	0.79847169	0	0	0	2.72E-06	0	2.16E-07	0	0	0	0	0
0.134	0.36	0.5159	0.000216	0.5158942	0	0	0	2.64E-06	0	2.96E-07	0	0	0	0	0
0.096	0.38	0.34396	0.000216	0.34396052	0	0	0	2.50E-06	0	4.41E-07	0	0	0	0	0
0.07	0.4	0.23276	0.000216	0.23276413	0	0	0	0	0	2.94E-06	0	0	0	0	0
0.009	0.42	0.02926	0.000216	0.0292625	0	0	0	0	0	2.94E-06	0	0	0	0.129275	0
0.005	0.44	0.01354	0.000216	0.01353564	0	0	0	0	0	2.94E-06	0	0	0	0.094592	0
0.003	0.46	0.00678	0.000216	0.00677651	0	0	0	0	0	2.94E-06	0	0	0	0.066809	0
0.001	0.48	0.0035	0.000216	0.00350197	0	0	0	0	0	2.94E-06	0	0	0	0.046334	0
8E-04	0.5	0.00183	0.000216	0.00183456	0	0	0	0	0	2.94E-06	0	0	0	0.03168	0
5E-04	0.52	0.00096	0.000216	0.00096486	0	0	0	0	0	2.94E-06	0	0	0	0.021374	0
3E-04	0.54	0.00051	0.000216	0.00050631	0	0	0	0	0	2.94E-06	0	0	0	0.014226	0
2E-04	0.56	0.00026	0.000216	0.00026389	0	0	0	0	0	2.94E-06	0	0	0	0.009333	0
1E-04	0.58	0.00014	0.000216	0.00013611	0	0	0	0	0	2.94E-06	0	0	0	0.00603	0
1E-04	0.6	6.93E-05	0.000216	6.93E-05	0	0	0	0	0	2.94E-06	0	0	0	0.003831	0
8E-05	0.62	3.47E-05	0.000216	3.47E-05	0	0	0	0	0	2.94E-06	0	0	0	0.00239	0
7E-05	0.64	1.70E-05	0.000216	1.70E-05	0	0	0	0	0	2.94E-06	0	0	0	0.001462	0
7E-05	0.66	8.17E-06	0.000216	8.17E-06	0	0	0	0	0	2.94E-06	0	0	0	0.000875	0
7E-05	0.68	3.83E-06	0.000216	3.83E-06	0	0	0	0	0	2.94E-06	0	0	0	0.000511	0
7E-05	0.7	1.74E-06	0.000216	1.74E-06	0	0	0	0	0	2.94E-06	0	0	0	0.000291	0
7E-05	0.72	7.68E-07	0.000216	7.68E-07	0	0	0	0	0	2.94E-06	0	0	0	0.000161	0
7E-05	0.74	3.27E-07	0.000216	3.27E-07	0	0	0	0	0	2.94E-06	0	0	0	8.59E-05	0
6E-05	0.76	1.33E-07	0.000216	1.33E-07	0	0	0	0	0	2.94E-06	0	0	0	4.42E-05	0
6E-05	0.78	5.20E-08	0.000216	5.20E-08	0	0	0	0	0	2.94E-06	0	0	0	2.18E-05	0
6E-05	0.8	1.92E-08	0.000216	1.92E-08	0	0	0	0	0	2.94E-06	0	0	0	1.03E-05	0
6E-05	0.82	6.67E-09	0.000216	6.67E-09	0	0	0	0	0	2.94E-06	0	0	0	4.57E-06	0
6E-05	0.84	2.15E-09	0.000216	2.15E-09	0	0	0	0	0	2.94E-06	0	0	0	1.90E-06	0
6E-05	0.86	6.36E-10	0.000216	6.36E-10	0	0	0	0	0	2.94E-06	0	0	0	7.27E-07	0
6E-05	0.88	1.68E-10	0.000216	1.68E-10	0	0	0	0	0	2.94E-06	0	0	0	2.52E-07	0
6E-05	0.9	3.88E-11	0.000216	3.88E-11	0	0	0	0	0	2.94E-06	0	0	0	7.64E-08	0

Table A.16: Consumer Decomposition Scenario β ($p_{O_1} = 0.4, p_{B_2} = 0.2, p_{O_2} = 0.3$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.61380	0.10002	0.10001	0.13882	0.08345	0.17192	0.53781	0.00396	1.00000	0.99999	1	0	0.04288	0.00016
1	20	0.59841	0.10002	0.10001	0.13882	1.83868	3.15117	1.41920	0.00474	0.99999	0.99999	1	0	0.91647	0.00020
1	40	0.60195	0.10003	0.10001	0.13882	3.58405	6.38395	2.38490	0.00475	0.99999	0.99999	1	0	1.79919	0.00021
1	60	0.58308	0.10002	0.10001	0.13882	6.10531	8.85008	3.07285	0.00567	1.00000	1.00000	1	0	2.94952	0.00025
1	80	0.60419	0.10002	0.10001	0.13882	7.05412	12.87996	4.32453	0.00497	0.99999	0.99999	1	0	3.55686	0.00024
1	100	0.57919	0.10002	0.10001	0.13882	10.42515	14.48928	4.70902	0.00611	1.00000	0.99999	1	0	4.99592	0.00028
20	1	0.26964	0.10016	0.10001	0.13882	2.09225	0.10754	7.96384	0.04072	0.99993	0.99990	1	0	0.35485	0.00166
20	20	0.61380	0.10002	0.10001	0.13882	1.66901	3.43842	10.75615	0.07919	1.00000	0.99999	1	0	0.85760	0.00318
20	40	0.58061	0.10002	0.10001	0.13882	4.18492	5.96599	11.39617	0.10759	0.99999	0.99999	1	0	2.01141	0.00429
20	60	0.62064	0.10002	0.10001	0.13882	4.69536	10.36625	12.86809	0.07405	1.00000	0.99999	1	0	2.44478	0.00300
20	80	0.61017	0.10001	0.10001	0.13882	6.78082	13.28224	13.69438	0.08263	0.99999	0.99999	1	0	3.45952	0.00334
20	100	0.59729	0.10001	0.10001	0.13882	9.29376	15.77232	14.36344	0.09356	0.99999	0.99999	1	0	4.62195	0.00378
40	1	0.26245	0.10061	0.10001	0.13882	4.12719	0.18395	15.76254	0.06948	0.99994	0.99992	1	0	0.67046	0.00286
40	20	0.62054	0.10002	0.10001	0.13882	1.60507	3.60762	20.56037	0.14743	0.99999	0.99999	1	0	0.83558	0.00593
40	40	0.61380	0.10002	0.10001	0.13882	3.33801	6.87684	21.51230	0.15838	1.00000	0.99999	1	0	1.71521	0.00636
40	60	0.60783	0.10002	0.10001	0.13882	5.21255	10.00524	22.41433	0.16832	0.99999	0.99999	1	0	2.64726	0.00676
40	80	0.58061	0.10002	0.10001	0.13882	8.36984	11.93198	22.79233	0.21518	0.99999	0.99999	1	0	4.02282	0.00858
40	100	0.61833	0.10002	0.10001	0.13882	7.97751	17.16617	24.64112	0.15160	0.99999	0.99999	1	0	4.13535	0.00613
60	1	0.27428	0.58341	0.10001	0.13882	5.70629	0.00022	24.21111	0.12619	0.99254	0.98569	1	0	0.99246	0.00514
60	20	0.61891	0.10006	0.10001	0.13882	1.64938	3.67935	30.30841	0.22497	1.00000	0.99999	1	0	0.85611	0.00904
60	40	0.60735	0.10002	0.10001	0.13882	3.53843	6.83313	31.17422	0.25330	0.99999	0.99999	1	0	1.79536	0.01015
60	60	0.61380	0.10002	0.10001	0.13882	5.00702	10.31526	32.26845	0.23757	1.00000	0.99999	1	0	2.57281	0.00955
60	80	0.60994	0.10002	0.10001	0.13882	6.84917	13.47362	33.18269	0.24717	1.00000	0.99999	1	0	3.49296	0.00993
60	100	0.56476	0.10002	0.10001	0.13882	11.57069	14.00203	32.87958	0.36429	0.99999	0.99999	1	0	5.37790	0.01447
80	1	0.27371	0.53392	0.10001	0.13882	7.63174	0.00203	32.19551	0.16704	0.98931	0.98412	1	0	1.32310	0.00681
80	20	0.31927	0.10006	0.10001	0.13882	9.78888	1.02666	33.89014	0.36193	0.99995	0.99993	1	0	2.14621	0.01439
80	40	0.62054	0.10002	0.10001	0.13882	3.21014	7.21524	41.12074	0.29486	0.99999	0.99999	1	0	1.67116	0.01186
80	60	0.60495	0.10001	0.10001	0.13882	5.39042	10.11892	41.84125	0.34577	1.00000	0.99999	1	0	2.72205	0.01384
80	80	0.61380	0.10002	0.10001	0.13882	6.67603	13.75368	43.02459	0.31676	1.00000	0.99999	1	0	3.43041	0.01273
80	100	0.60665	0.10001	0.10001	0.13882	8.78569	16.67691	43.81757	0.34040	0.99999	0.99999	1	0	4.45153	0.01365
100	1	0.27572	0.69821	0.10001	0.13882	9.43218	0.00000	40.31315	0.22001	0.99077	0.98700	1	0	1.65405	0.00894
100	20	0.30925	0.10008	0.10001	0.13882	11.63977	1.08308	41.88372	0.39827	0.99991	0.99986	1	0	2.43498	0.01588
100	40	0.57335	0.10002	0.10001	0.13882	4.61887	6.35515	50.02999	0.56873	0.99999	0.99999	1	0	2.18651	0.02258
100	60	0.61078	0.10002	0.10001	0.13882	5.18353	10.41624	51.70774	0.40795	1.00000	0.99999	1	0	2.64781	0.01635
100	80	0.59872	0.10002	0.10001	0.13882	7.51445	13.16984	52.37414	0.45859	0.99999	0.99999	1	0	3.74787	0.01833
100	100	0.61380	0.10002	0.10001	0.13882	8.34503	17.19210	53.78074	0.39595	1.00000	0.99999	1	0	4.28802	0.01591

Table A.17: Scenario 1 ($p_{B_2} = 0.10001, p_{O_2} = p\tilde{_{O_2}}, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.2158211	0.1002766	0.2742333	0.10001	0.17467	0.00761	0.09487	0.00675	0.99997	0.99996	1	0	0.02023	0.01653
1	20	0.3966579	0.1000259	0.2742333	0.10001	0.17106	0.04251	0.82821	0.04802	0.99977	0.99991	1	0	0.05074	0.14430
1	40	0.4296434	0.1000314	0.2742333	0.10001	0.28045	0.08947	1.99961	0.09588	0.99971	0.99979	1	0	0.09240	0.34840
1	60	0.4390163	0.1000191	0.2742333	0.10001	0.39825	0.13600	3.14432	0.14225	0.99991	0.99991	1	0	0.13501	0.54785
1	80	0.4467133	0.1000178	0.2742333	0.10001	0.51212	0.18677	4.39690	0.19294	0.99993	0.99993	1	0	0.17755	0.76609
1	100	0.4453211	0.1000226	0.2742333	0.10001	0.63769	0.22747	5.40315	0.23363	0.99990	0.99988	1	0	0.22019	0.94141
20	1	0.2158142	0.2022802	0.2742333	0.10001	3.37690	0.01867	2.13050	0.14895	0.99262	0.99180	1	0	0.39160	0.37121
20	20	0.2148697	0.1003385	0.2742333	0.10001	3.52196	0.15106	1.90610	0.13456	0.99995	0.99995	1	0	0.40453	0.33211
20	40	0.2216067	0.100099	0.2742333	0.10001	3.48471	0.16186	1.95714	0.14225	0.99998	0.99998	1	0	0.42376	0.34100
20	60	0.2238249	0.100111	0.2742333	0.10001	3.58309	0.16719	2.05228	0.14823	0.99991	0.99988	1	0	0.44336	0.35758
20	80	0.2267065	0.1000713	0.2742333	0.10001	3.66259	0.17383	2.12776	0.15397	0.99996	0.99995	1	0	0.46400	0.37073
20	100	0.2345663	0.1000742	0.2742333	0.10001	3.60285	0.18754	2.26831	0.16807	0.99993	0.99990	1	0	0.48454	0.39522
40	1	0.2152293	0.3140916	0.2742333	0.10001	6.79140	0.02029	3.95411	0.28008	0.99347	0.98734	1	0	0.78248	0.68894
40	20	0.2137046	0.1019509	0.2742333	0.10001	6.94893	0.28679	3.94847	0.27294	0.99990	0.99991	1	0	0.79044	0.68796
40	40	0.2148697	0.1003385	0.2742333	0.10001	7.04392	0.30211	3.81220	0.26913	0.99995	0.99995	1	0	0.80907	0.66421
40	60	0.2162246	0.1001548	0.2742333	0.10001	7.12671	0.30867	3.84112	0.27244	0.99995	0.99993	1	0	0.82814	0.66925
40	80	0.2216067	0.100099	0.2742333	0.10001	6.96943	0.32371	3.91427	0.28450	0.99998	0.99998	1	0	0.84752	0.68200
40	100	0.224209	0.1000971	0.2742333	0.10001	6.98048	0.33259	4.01018	0.29319	0.99996	0.99994	1	0	0.86688	0.69871
60	1	0.2159151	0.3414567	0.2742333	0.10001	10.12798	0.02296	5.74014	0.42967	0.98984	0.98268	1	0	1.17294	1.00013
60	20	0.2162005	0.1423313	0.2742333	0.10001	10.10443	0.15134	10.45047	0.59863	0.99977	0.99974	1	0	1.17958	1.82083
60	40	0.2161823	0.1007134	0.2742333	0.10001	10.28296	0.45102	5.72800	0.40712	0.99995	0.99992	1	0	1.19485	0.99801
60	60	0.2163655	0.1003208	0.2742333	0.10001	10.43053	0.45807	5.71507	0.40704	0.99997	0.99996	1	0	1.21381	0.99576
60	80	0.2146469	0.1000992	0.2742333	0.10001	10.75249	0.45729	5.67812	0.40150	0.99996	0.99995	1	0	1.23263	0.98932
60	100	0.2181679	0.1001904	0.2742333	0.10001	10.59530	0.47028	5.84196	0.41670	0.99995	0.99995	1	0	1.25188	1.01787
80	1	0.2164861	0.3096692	0.2742333	0.10001	13.43369	0.04218	7.52419	0.56867	0.99282	0.99225	1	0	1.56468	1.31097
80	20	0.2171587	0.1580288	0.2742333	0.10001	13.35597	0.13357	13.16431	0.77155	0.99802	0.99795	1	0	1.56941	2.29367
80	40	0.2137046	0.1019509	0.2742333	0.10001	13.89786	0.57359	7.89695	0.54588	0.99990	0.99991	1	0	1.58088	1.37592
80	60	0.2142031	0.1004559	0.2742333	0.10001	14.00565	0.59729	7.56665	0.53359	0.99997	0.99988	1	0	1.59955	1.31837
80	80	0.2148697	0.1003385	0.2742333	0.10001	14.08783	0.60422	7.62440	0.53825	0.99995	0.99995	1	0	1.61814	1.32843
80	100	0.2165123	0.1002655	0.2742333	0.10001	14.05251	0.61437	7.68693	0.54575	0.99997	0.99988	1	0	1.63720	1.33932
100	1	0.2165513	0.2537165	0.2742333	0.10001	16.77506	0.09910	9.30138	0.68309	0.99456	0.99150	1	0	1.95680	1.62062
100	20	0.2158787	0.1518243	0.2742333	0.10001	16.87413	0.19752	14.60997	0.88647	0.99834	0.99861	1	0	1.96208	2.54555
100	40	0.2141904	0.112616	0.2742333	0.10001	17.19149	0.56231	12.70464	0.79881	0.99983	0.99974	1	0	1.96835	2.21358
100	60	0.2152484	0.1006767	0.2742333	0.10001	17.22629	0.74683	9.46944	0.67182	0.99995	0.99995	1	0	1.98544	1.64990
100	80	0.2155271	0.1003627	0.2742333	0.10001	17.34976	0.75595	9.43837	0.67175	0.99992	0.99989	1	0	2.00393	1.64448
100	100	0.2152199	0.1002188	0.2742333	0.10001	17.55965	0.75924	9.43868	0.67053	0.99995	0.99995	1	0	2.02288	1.64454

Table A.18: Scenario 2 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.4411114	0.1000427	0.10001	0.1388218	0.20798	0.07231	0.58356	0.00001	0.99995	0.99992	0	1	0.07094	0.00001
1	20	0.5514157	0.1000219	0.10001	0.1388218	2.52904	2.58910	3.67536	0.00025	0.99999	0.99998	0	1	1.14170	0.00005
1	40	0.5760641	0.1000172	0.10001	0.1388218	4.39445	5.82812	7.08843	0.00052	0.99999	0.99999	0	1	2.09214	0.00009
1	60	0.5769648	0.1000153	0.10001	0.1388218	6.55509	8.77705	10.40104	0.00078	0.99999	0.99999	0	1	3.12668	0.00013
1	80	0.6003274	0.1000191	0.10001	0.1388218	7.49569	12.92821	14.02068	0.00107	1.00000	0.99999	0	1	3.75054	0.00018
1	100	0.6160941	0.1000168	0.10001	0.1388218	8.34531	17.17337	17.60702	0.00136	1.00000	0.99999	0	1	4.30725	0.00023
20	1	0.2577803	0.1001519	0.10001	0.1388218	2.22333	0.10929	7.86897	0.00076	0.99997	0.99995	0	1	0.35078	0.00011
20	20	0.4411114	0.1000427	0.10001	0.1388218	4.15950	1.44616	11.67120	0.00019	0.99995	0.99992	0	1	1.41884	0.00012
20	40	0.6157652	0.1000161	0.10001	0.1388218	3.35600	6.89785	16.60181	0.00054	0.99999	0.99999	0	1	1.73102	0.00019
20	60	0.5489008	0.1000245	0.10001	0.1388218	7.72607	7.74115	19.16717	0.00074	0.99999	0.99999	0	1	3.46842	0.00022
20	80	0.5485382	0.1000195	0.10001	0.1388218	10.30750	10.27561	22.34041	0.00099	0.99999	0.99999	0	1	4.62350	0.00026
20	100	0.6354735	0.1000134	0.10001	0.1388218	7.13509	18.40330	27.08927	0.00138	1.00000	0.99999	0	1	3.82090	0.00032
40	1	0.2557276	0.1002897	0.10001	0.1388218	4.25527	0.20560	15.64539	0.00159	0.99995	0.99993	0	1	0.66262	0.00022
40	20	0.5586793	0.1000237	0.10001	0.1388218	2.50303	2.83738	22.52108	0.00025	1.00000	0.99999	0	1	1.14815	0.00024
40	40	0.4411114	0.1000427	0.10001	0.1388218	8.31900	2.89232	23.34240	0.00037	0.99995	0.99992	0	1	2.83768	0.00025
40	60	0.555441	0.1000161	0.10001	0.1388218	7.49899	8.07845	28.91756	0.00075	0.99999	0.99999	0	1	3.41547	0.00032
40	80	0.6157652	0.1000161	0.10001	0.1388218	6.71200	13.79571	33.20362	0.00109	0.99999	0.99999	0	1	3.46204	0.00037
40	100	0.5528864	0.1000198	0.10001	0.1388218	12.61985	13.18962	35.27083	0.00125	1.00000	0.99999	0	1	5.71562	0.00040
60	1	0.2622983	0.2734813	0.10001	0.1388218	6.00225	0.05218	23.80957	0.03832	0.99976	0.99968	0	1	0.98257	0.00173
60	20	0.5683031	0.1000163	0.10001	0.1388218	2.39021	3.01975	32.27436	0.00026	1.00000	0.99999	0	1	1.11939	0.00033
60	40	0.4203036	0.1000458	0.10001	0.1388218	9.31966	2.71286	31.91771	0.00036	0.99996	0.99992	0	1	2.98514	0.00033
60	60	0.4412161	0.1000456	0.10001	0.1388218	12.47308	4.34089	35.01761	0.00056	0.99995	0.99991	0	1	4.25595	0.00037
60	80	0.5619208	0.1000177	0.10001	0.1388218	9.64861	11.12444	41.93391	0.00102	0.99999	0.99998	0	1	4.45709	0.00046
60	100	0.5645288	0.1000251	0.10001	0.1388218	11.85215	14.01164	45.25210	0.00128	0.99999	0.99998	0	1	5.50600	0.00050
80	1	0.2598782	0.2656114	0.10001	0.1388218	8.12245	0.07223	31.57564	0.04737	0.99974	0.99961	0	1	1.31012	0.00215
80	20	0.3278154	0.1000406	0.10001	0.1388218	9.20961	1.12142	35.51615	0.00063	0.99998	0.99997	0	1	2.09808	0.00038
80	40	0.5586793	0.1000237	0.10001	0.1388218	5.00606	5.67475	45.04216	0.00051	1.00000	0.99999	0	1	2.29631	0.00047
80	60	0.6490493	0.1000247	0.10001	0.1388218	3.80319	11.59202	49.64515	0.00083	1.00000	0.99999	0	1	2.08843	0.00053
80	80	0.4411114	0.1000427	0.10001	0.1388218	16.63800	5.78464	46.68479	0.00075	0.99995	0.99992	0	1	5.67535	0.00050
80	100	0.4719375	0.1000503	0.10001	0.1388218	18.38213	8.59530	50.90340	0.00102	0.99984	0.99974	0	1	6.83469	0.00055
100	1	0.2625617	0.2775757	0.10001	0.1388218	9.98683	0.08567	39.58306	0.06730	0.99987	0.99985	0	1	1.63810	0.00301
100	20	0.2993148	0.1000554	0.10001	0.1388218	12.04678	1.03150	42.52277	0.00146	0.99997	0.99996	0	1	2.40107	0.00048
100	40	0.5141193	0.100022	0.10001	0.1388218	6.48051	4.80373	53.59898	0.00046	0.99999	0.99999	0	1	2.68381	0.00055
100	60	0.6576319	0.1000151	0.10001	0.1388218	3.50587	11.89687	59.52427	0.00084	1.00000	0.99999	0	1	1.95517	0.00063
100	80	0.6209624	0.1000297	0.10001	0.1388218	6.46708	14.14938	62.55531	0.00109	1.00000	0.99999	0	1	3.36952	0.00067
100	100	0.4411114	0.1000427	0.10001	0.1388218	20.79750	7.23080	58.35599	0.00093	0.99995	0.99992	0	1	7.09419	0.00062

Table A.19: Scenario 3 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.3723012	0.1000506	0.2742333	0.10001	0.14995	0.01781	0.35743	0.01211	0.99995	0.99995	0	1	0.04083	0.06228
1	20	0.4538226	0.1000531	0.2742333	0.10001	1.97460	0.37811	6.40712	0.13557	0.99993	0.99989	0	1	0.69863	1.11634
1	40	0.4563819	0.1000697	0.2742333	0.10001	3.90681	0.76272	12.75806	0.26433	0.99982	0.99982	0	1	1.39210	2.22288
1	60	0.4501086	0.1000732	0.2742333	0.10001	5.96094	1.08722	18.71236	0.38484	0.99978	0.99976	0	1	2.08622	3.26032
1	80	0.4523098	0.1000649	0.2742333	0.10001	7.89957	1.47291	25.07150	0.51412	0.99994	0.99992	0	1	2.78307	4.36829
1	100	0.4580874	0.1000383	0.2742333	0.10001	9.71202	1.92337	31.82688	0.65074	0.99996	0.99994	0	1	3.47774	5.54531
20	1	0.2120156	0.1007726	0.2742333	0.10001	3.55662	0.04202	1.78180	0.10272	0.99995	0.99987	0	1	0.39833	0.31045
20	20	0.3741966	0.1000499	0.2742333	0.10001	2.97747	0.35990	7.20119	0.24378	0.99992	0.99991	0	1	0.81633	1.25469
20	40	0.4178189	0.1000743	0.2742333	0.10001	4.66698	0.72146	13.93366	0.39021	0.99989	0.99987	0	1	1.48308	2.42771
20	60	0.4305183	0.1000395	0.2742333	0.10001	6.57468	1.08689	20.31894	0.52184	0.99996	0.99992	0	1	2.17305	3.54024
20	80	0.4344415	0.100047	0.2742333	0.10001	8.56615	1.43322	26.46110	0.64735	0.99995	0.99996	0	1	2.86486	4.61041
20	100	0.4323294	0.1000525	0.2742333	0.10001	10.69872	1.72433	32.13480	0.76188	0.99994	0.99991	0	1	3.55536	5.59896
40	1	0.2122156	0.1040987	0.2742333	0.10001	6.96828	0.07577	3.51000	0.20548	0.99983	0.99973	0	1	0.78178	0.61156
40	20	0.23891	0.1001554	0.2742333	0.10001	7.89027	0.16878	5.40209	0.24171	0.99989	0.99985	0	1	1.09516	0.94123
40	40	0.3741966	0.1000499	0.2742333	0.10001	5.95494	0.71980	14.40238	0.48756	0.99992	0.99991	0	1	1.63267	2.50938
40	60	0.4097329	0.1000467	0.2742333	0.10001	7.38607	1.11720	21.72145	0.65216	0.99994	0.99990	0	1	2.28756	3.78461
40	80	0.4178189	0.1000743	0.2742333	0.10001	9.33396	1.44293	27.86732	0.78042	0.99989	0.99987	0	1	2.96617	4.85542
40	100	0.4287333	0.1000455	0.2742333	0.10001	11.11885	1.84488	34.63128	0.92138	0.99996	0.99992	0	1	3.65511	6.03393
60	1	0.2139139	0.2280351	0.2742333	0.10001	10.23315	0.01606	5.66671	0.78583	0.99656	0.98822	0	1	1.16428	0.98734
60	20	0.2273105	0.1001241	0.2742333	0.10001	11.53148	0.19681	6.91350	0.33874	0.99993	0.99990	0	1	1.46735	1.20456
60	40	0.3266629	0.1000964	0.2742333	0.10001	8.17707	0.67666	13.88370	0.53454	0.99988	0.99981	0	1	1.85265	2.41901
60	60	0.3743636	0.1000504	0.2742333	0.10001	8.92672	1.08071	21.61767	0.73178	0.99992	0.99991	0	1	2.44893	3.76653
60	80	0.3922911	0.100091	0.2742333	0.10001	10.59582	1.40454	28.13346	0.87753	0.99983	0.99986	0	1	3.09590	4.90179
60	100	0.4096303	0.1000771	0.2742333	0.10001	12.17106	1.80084	35.27133	1.03276	0.99992	0.99983	0	1	3.76814	6.14545
80	1	0.2137616	0.3307666	0.2742333	0.10001	13.64898	0.01183	7.52406	2.56504	0.99533	0.98636	0	1	1.55108	1.31097
80	20	0.2250174	0.1001093	0.2742333	0.10001	14.76445	0.24380	8.57380	0.43853	0.99997	0.99993	0	1	1.84569	1.49385
80	40	0.23891	0.1001554	0.2742333	0.10001	15.78053	0.33756	10.80418	0.48341	0.99989	0.99985	0	1	2.19033	1.88245
80	60	0.3540606	0.1000533	0.2742333	0.10001	10.43964	1.12855	22.31102	0.82215	0.99997	0.99996	0	1	2.65231	3.88733
80	80	0.3741966	0.1000499	0.2742333	0.10001	11.90988	1.43959	28.80475	0.97513	0.99992	0.99991	0	1	3.26534	5.01876
80	100	0.3860815	0.1000862	0.2742333	0.10001	13.66489	1.73612	35.01729	1.11217	0.99981	0.99966	0	1	3.90660	6.10119
100	1	0.2143083	0.4335525	0.2742333	0.10001	16.97818	0.00179	9.37565	6.73771	0.99486	0.99121	0	1	1.93822	1.63362
100	20	0.2240403	0.1000867	0.2742333	0.10001	17.93930	0.29366	10.25311	0.53873	0.99998	0.99998	0	1	2.22514	1.78644
100	40	0.2297797	0.1001052	0.2742333	0.10001	19.73900	0.35143	12.20168	0.57811	0.99992	0.99990	0	1	2.56028	2.12594
100	60	0.2461594	0.1000632	0.2742333	0.10001	20.02897	0.48634	14.83418	0.62985	0.99997	0.99997	0	1	2.92736	2.58461
100	80	0.3647988	0.1000376	0.2742333	0.10001	13.05534	1.53996	30.23848	1.08970	0.99998	0.99998	0	1	3.45706	5.26856
100	100	0.3723012	0.1000506	0.2742333	0.10001	14.99518	1.78071	35.74285	1.21128	0.99995	0.99995	0	1	4.08310	6.22761

Table A.20: Scenario 4 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.08345	0.17192	0.00135	0.00000	0.00000	0.00000	0.00002	0.08208	0.00004	0.16692	0.00000	0.00000	0.00495	0.00000
1	20	1.83868	3.15117	0.00185	0.00000	0.00000	0.00000	0.00049	1.83634	0.00084	3.14458	0.00000	0.00000	0.00576	0.00000
1	40	3.58405	6.38395	0.00172	0.00000	0.00000	0.00000	0.00096	3.58137	0.00171	6.37668	0.00000	0.00000	0.00557	0.00000
1	60	6.10531	8.85008	0.00249	0.00000	0.00000	0.00000	0.00163	6.10119	0.00236	8.84112	0.00000	0.00000	0.00660	0.00000
1	80	7.05412	12.87996	0.00164	0.00000	0.00000	0.00000	0.00189	7.05059	0.00344	12.87107	0.00000	0.00000	0.00545	0.00000
1	100	10.42515	14.48927	0.00268	0.00000	0.00000	0.00000	0.00279	10.41968	0.00387	14.47859	0.00000	0.00000	0.00681	0.00000
20	1	2.09205	0.10752	1.85310	0.00000	0.00000	0.00000	0.00006	0.23889	0.00000	0.00898	0.00000	0.00000	0.09853	0.00000
20	20	1.66901	3.43842	0.02693	0.00000	0.00000	0.00000	0.00044	1.64164	0.00089	3.33846	0.00000	0.00000	0.09906	0.00000
20	40	4.18492	5.96599	0.05215	0.00000	0.00000	0.00000	0.00110	4.13166	0.00156	5.82977	0.00000	0.00000	0.13466	0.00000
20	60	4.69536	10.36625	0.02326	0.00000	0.00000	0.00000	0.00125	4.67085	0.00275	10.27126	0.00000	0.00000	0.09225	0.00000
20	80	6.78081	13.28224	0.02905	0.00000	0.00000	0.00000	0.00181	6.74996	0.00352	13.17595	0.00000	0.00000	0.10277	0.00000
20	100	9.29376	15.77232	0.03777	0.00000	0.00000	0.00000	0.00247	9.25352	0.00419	15.65181	0.00000	0.00000	0.11633	0.00000
40	1	4.12701	0.18390	3.89070	0.00000	0.00000	0.00000	0.00006	0.23625	0.00000	0.00786	0.00000	0.00000	0.17604	0.00000
40	20	1.60507	3.60762	0.04663	0.00000	0.00000	0.00000	0.00042	1.55802	0.00092	3.42202	0.00000	0.00000	0.18469	0.00000
40	40	3.33801	6.87684	0.05385	0.00000	0.00000	0.00000	0.00088	3.28328	0.00179	6.67692	0.00000	0.00000	0.19813	0.00000
40	60	5.21255	10.00524	0.06100	0.00000	0.00000	0.00000	0.00138	5.15018	0.00262	9.79226	0.00000	0.00000	0.21036	0.00000
40	80	8.36983	11.93198	0.10429	0.00000	0.00000	0.00000	0.00221	8.26333	0.00312	11.65955	0.00000	0.00000	0.26931	0.00000
40	100	7.97750	17.16616	0.04890	0.00000	0.00000	0.00000	0.00212	7.92648	0.00454	16.97257	0.00000	0.00000	0.18905	0.00000
60	1	5.70150	0.00000	5.70150	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
60	20	1.64938	3.67935	0.07247	0.00000	0.00000	0.00000	0.00042	1.57649	0.00091	3.39662	0.00000	0.00000	0.28182	0.00000
60	40	3.53843	6.83313	0.09242	0.00000	0.00000	0.00000	0.00092	3.44509	0.00174	6.51434	0.00000	0.00000	0.31705	0.00000
60	60	5.00702	10.31526	0.08078	0.00000	0.00000	0.00000	0.00132	4.92493	0.00268	10.01539	0.00000	0.00000	0.29719	0.00000
60	80	6.84917	13.47362	0.08757	0.00000	0.00000	0.00000	0.00181	6.75979	0.00352	13.16110	0.00000	0.00000	0.30899	0.00000
60	100	11.57069	14.00203	0.20894	0.00000	0.00000	0.00000	0.00304	11.35871	0.00362	13.54097	0.00000	0.00000	0.45744	0.00000
80	1	7.62682	0.00000	7.62682	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
80	20	9.78846	1.02660	5.17261	0.00000	0.00000	0.00000	0.00123	4.61462	0.00010	0.35866	0.00000	0.00000	0.66785	0.00000
80	40	3.21013	7.21524	0.09325	0.00000	0.00000	0.00000	0.00083	3.11605	0.00183	6.84404	0.00000	0.00000	0.36937	0.00000
80	60	5.39041	10.11892	0.12943	0.00000	0.00000	0.00000	0.00141	5.25957	0.00259	9.68358	0.00000	0.00000	0.43275	0.00000
80	80	6.67603	13.75367	0.10770	0.00000	0.00000	0.00000	0.00176	6.56657	0.00357	13.35385	0.00000	0.00000	0.39626	0.00000
80	100	8.78568	16.67692	0.12499	0.00000	0.00000	0.00000	0.00232	8.65837	0.00434	16.24694	0.00000	0.00000	0.42563	0.00000
100	1	9.42381	0.00000	9.42381	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
100	20	11.63837	1.08294	6.98167	0.00000	0.00000	0.00000	0.00124	4.65545	0.00008	0.31508	0.00000	0.00000	0.76777	0.00000
100	40	4.61886	6.35514	0.29828	0.00000	0.00000	0.00000	0.00116	4.31943	0.00151	5.63969	0.00000	0.00000	0.71395	0.00000
100	60	5.18353	10.41624	0.14344	0.00000	0.00000	0.00000	0.00135	5.03874	0.00265	9.90287	0.00000	0.00000	0.51072	0.00000
100	80	7.51444	13.16984	0.18353	0.00000	0.00000	0.00000	0.00196	7.32895	0.00337	12.59251	0.00000	0.00000	0.57396	0.00000
100	100	8.34503	17.19209	0.13463	0.00000	0.00000	0.00000	0.00220	8.20821	0.00446	16.69231	0.00000	0.00000	0.49532	0.00000

Table A.21: Consumer Drift Scenario 1 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.17465	0.00761	0.09377	0.07280	0.00000	0.00000	0.00808	0.00000	0.00012	0.00000	0.00000	0.00523	0.00128	0.00099
1	20	0.17011	0.04231	0.03265	0.00000	0.00000	0.00000	0.13746	0.00000	0.02782	0.00000	0.00000	0.00248	0.01200	0.00000
1	40	0.27861	0.08885	0.02297	0.00000	0.00000	0.00000	0.25563	0.00000	0.07454	0.00000	0.00000	0.00199	0.01232	0.00000
1	60	0.39558	0.13512	0.02063	0.00000	0.00000	0.00000	0.37495	0.00000	0.12099	0.00000	0.00000	0.00187	0.01226	0.00000
1	80	0.50867	0.18554	0.01883	0.00000	0.00000	0.00000	0.48984	0.00000	0.17161	0.00000	0.00000	0.00177	0.01216	0.00000
1	100	0.63346	0.22596	0.01915	0.00000	0.00000	0.00000	0.61431	0.00000	0.21199	0.00000	0.00000	0.00178	0.01218	0.00000
20	1	3.37713	0.00407	1.90097	1.47610	0.00000	0.00000	0.00007	0.00000	0.00000	0.00000	0.00000	0.00406	0.00001	0.00000
20	20	3.52154	0.15103	1.87624	1.48407	0.00000	0.00000	0.16124	0.00000	0.00232	0.00000	0.00000	0.10440	0.02474	0.01957
20	40	3.48399	0.16184	1.87042	1.28899	0.00000	0.00000	0.32458	0.00000	0.00535	0.00000	0.00000	0.10489	0.03055	0.02106
20	60	3.58066	0.16712	1.86840	1.22633	0.00000	0.00000	0.48593	0.00000	0.00834	0.00000	0.00000	0.10482	0.03258	0.02138
20	80	3.66018	0.17378	1.86561	1.14602	0.00000	0.00000	0.64855	0.00000	0.01175	0.00000	0.00000	0.10493	0.03537	0.02173
20	100	3.59875	0.18745	1.85728	0.93338	0.00000	0.00000	0.80809	0.00000	0.01688	0.00000	0.00000	0.10490	0.04370	0.02196
40	1	6.78823	0.00000	3.80195	2.98628	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
40	20	6.94806	0.28655	3.75663	3.03889	0.00000	0.00000	0.15255	0.00000	0.00208	0.00000	0.00000	0.20248	0.04532	0.03666
40	40	7.04308	0.30207	3.75247	2.96813	0.00000	0.00000	0.32248	0.00000	0.00465	0.00000	0.00000	0.20880	0.04948	0.03914
40	60	7.12496	0.30862	3.75005	2.88838	0.00000	0.00000	0.48653	0.00000	0.00722	0.00000	0.00000	0.20952	0.05190	0.03998
40	80	6.96798	0.32368	3.74084	2.57799	0.00000	0.00000	0.64915	0.00000	0.01069	0.00000	0.00000	0.20977	0.06111	0.04211
40	100	6.97779	0.33252	3.73607	2.43110	0.00000	0.00000	0.81062	0.00000	0.01402	0.00000	0.00000	0.20975	0.06588	0.04287
60	1	10.12243	0.00000	5.70293	4.41951	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
60	20	10.10269	0.14849	5.68823	4.38331	0.00000	0.00000	0.03115	0.00000	0.00019	0.00000	0.00000	0.12227	0.01470	0.01133
60	40	10.28202	0.45093	5.62652	4.33732	0.00000	0.00000	0.31818	0.00000	0.00467	0.00000	0.00000	0.31096	0.07641	0.05890
60	60	10.42956	0.45803	5.62515	4.32054	0.00000	0.00000	0.48388	0.00000	0.00718	0.00000	0.00000	0.31333	0.07778	0.05974
60	80	10.75046	0.45724	5.62868	4.47146	0.00000	0.00000	0.65033	0.00000	0.00938	0.00000	0.00000	0.31463	0.07425	0.05899
60	100	10.59296	0.47022	5.62039	4.16302	0.00000	0.00000	0.80954	0.00000	0.01247	0.00000	0.00000	0.31408	0.08253	0.06113
80	1	13.43028	0.00000	7.60390	5.82638	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
80	20	13.35243	0.11793	7.59538	5.74208	0.00000	0.00000	0.01496	0.00000	0.00006	0.00000	0.00000	0.10290	0.00852	0.00644
80	40	13.89613	0.57310	7.51325	6.07777	0.00000	0.00000	0.30510	0.00000	0.00417	0.00000	0.00000	0.40495	0.09065	0.07333
80	60	14.00428	0.59720	7.50742	6.01526	0.00000	0.00000	0.48160	0.00000	0.00683	0.00000	0.00000	0.41658	0.09649	0.07731
80	80	14.08617	0.60414	7.50494	5.93626	0.00000	0.00000	0.64496	0.00000	0.00930	0.00000	0.00000	0.41760	0.09896	0.07827
80	100	14.05042	0.61429	7.49959	5.74346	0.00000	0.00000	0.80737	0.00000	0.01202	0.00000	0.00000	0.41807	0.10431	0.07989
100	1	16.77841	0.00011	9.50488	7.27353	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00011	0.00000	0.00000
100	20	16.87041	0.18138	9.49039	7.35990	0.00000	0.00000	0.02012	0.00000	0.00010	0.00000	0.00000	0.15555	0.01449	0.01124
100	40	17.18592	0.55574	9.42476	7.55337	0.00000	0.00000	0.20779	0.00000	0.00231	0.00000	0.00000	0.40910	0.08012	0.06421
100	60	17.22481	0.74670	9.38102	7.36565	0.00000	0.00000	0.47814	0.00000	0.00690	0.00000	0.00000	0.51869	0.12386	0.09725
100	80	17.34648	0.75578	9.37870	7.32375	0.00000	0.00000	0.64403	0.00000	0.00939	0.00000	0.00000	0.52167	0.12618	0.09853
100	100	17.55720	0.75913	9.37934	7.36843	0.00000	0.00000	0.80944	0.00000	0.01178	0.00000	0.00000	0.52319	0.12554	0.09862

Table A.22: Consumer Drift Scenario 2 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.20797	0.07230	0.01486	0.00000	0.00000	0.00231	0.00371	0.18709	0.00122	0.06173	0.00000	0.00032	0.00903	0.00000
1	20	2.52904	2.58910	0.00215	0.00000	0.00000	0.03311	0.04850	2.44529	0.05027	2.53460	0.00000	0.00014	0.00409	0.00000
1	40	4.39445	5.82812	0.00125	0.00000	0.00000	0.05921	0.08429	4.24970	0.11328	5.71165	0.00000	0.00011	0.00308	0.00000
1	60	6.55509	8.77705	0.00123	0.00000	0.00000	0.08843	0.12574	6.33970	0.17063	8.60327	0.00000	0.00011	0.00305	0.00000
1	80	7.49568	12.92820	0.00070	0.00000	0.00000	0.10427	0.14374	7.24697	0.25139	12.67448	0.00000	0.00009	0.00224	0.00000
1	100	8.34531	17.17337	0.00047	0.00000	0.00000	0.11878	0.15998	8.06608	0.33395	16.83756	0.00000	0.00008	0.00179	0.00000
20	1	2.22328	0.10928	1.97529	0.00000	0.00000	0.00276	0.00478	0.24045	0.00015	0.00747	0.00000	0.02017	0.08149	0.00000
20	20	4.15950	1.44606	0.29725	0.00000	0.00000	0.04614	0.07421	3.74189	0.02448	1.23456	0.00000	0.00643	0.18058	0.00000
20	40	3.35600	6.89785	0.00955	0.00000	0.00000	0.04761	0.06415	3.23469	0.13342	6.72702	0.00000	0.00153	0.03589	0.00000
20	60	7.72607	7.74115	0.04523	0.00000	0.00000	0.10037	0.14744	7.43303	0.14887	7.50537	0.00000	0.00281	0.08409	0.00000
20	80	10.30750	10.27561	0.04557	0.00000	0.00000	0.13403	0.19696	9.93093	0.19814	9.99024	0.00000	0.00282	0.08441	0.00000
20	100	7.13509	18.40330	0.00564	0.00000	0.00000	0.10468	0.13661	6.88817	0.35734	18.01834	0.00000	0.00125	0.02636	0.00000
40	1	4.25511	0.20557	4.00796	0.00000	0.00000	0.00276	0.00478	0.23961	0.00014	0.00718	0.00000	0.04080	0.15744	0.00000
40	20	2.50303	2.83737	0.07355	0.00000	0.00000	0.03209	0.04663	2.35076	0.05215	2.62883	0.00000	0.00517	0.15122	0.00000
40	40	8.31900	2.89211	0.59451	0.00000	0.00000	0.09229	0.14842	7.48378	0.04897	2.46912	0.00000	0.01285	0.36117	0.00000
40	60	7.49899	8.07845	0.07882	0.00000	0.00000	0.09764	0.14240	7.18013	0.15395	7.76243	0.00000	0.00532	0.15675	0.00000
40	80	6.71200	13.79571	0.01910	0.00000	0.00000	0.09521	0.12831	6.46938	0.26683	13.45403	0.00000	0.00306	0.07178	0.00000
40	100	12.61985	13.18961	0.08320	0.00000	0.00000	0.16452	0.24062	12.13151	0.25328	12.76973	0.00000	0.00544	0.16117	0.00000
60	1	6.00104	0.05234	6.00101	0.00000	0.00000	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000	0.05234	0.00000	0.00000
60	20	2.39021	3.01975	0.08942	0.00000	0.00000	0.03072	0.04415	2.22592	0.05464	2.75489	0.00000	0.00713	0.20309	0.00000
60	40	9.31956	2.71276	1.19045	0.00000	0.00000	0.09591	0.15623	7.87697	0.04115	2.07490	0.00000	0.02226	0.57446	0.00000
60	60	12.47304	4.34057	0.89040	0.00000	0.00000	0.13840	0.22255	11.22169	0.07350	3.70625	0.00000	0.01927	0.54155	0.00000
60	80	9.64861	11.12444	0.10286	0.00000	0.00000	0.12652	0.18317	9.23606	0.21194	10.68627	0.00000	0.00754	0.21869	0.00000
60	100	11.85214	14.01164	0.09718	0.00000	0.00000	0.15630	0.22558	11.37308	0.26824	13.52378	0.00000	0.00737	0.21223	0.00000
80	1	8.12161	0.07243	8.12157	0.00000	0.00000	0.00004	0.00000	0.00000	0.00000	0.00000	0.00000	0.07243	0.00000	0.00000
80	20	9.20951	1.12142	4.48768	0.00000	0.00000	0.05340	0.09082	4.57761	0.00792	0.39919	0.00000	0.05359	0.66072	0.00000
80	40	5.00606	5.67475	0.14710	0.00000	0.00000	0.06418	0.09326	4.70151	0.10429	5.25767	0.00000	0.01034	0.30245	0.00000
80	60	3.80319	11.59201	0.01536	0.00000	0.00000	0.05698	0.07257	3.65828	0.22376	11.28002	0.00000	0.00435	0.08388	0.00000
80	80	16.63799	5.78422	1.18901	0.00000	0.00000	0.18458	0.29684	14.96756	0.09794	4.93824	0.00000	0.02571	0.72234	0.00000
80	100	18.38290	8.59187	0.74316	0.00000	0.00000	0.21526	0.33842	17.08605	0.15430	7.78998	0.00000	0.02061	0.62699	0.00000
100	1	9.98569	0.08574	9.98566	0.00000	0.00000	0.00002	0.00000	0.00000	0.00000	0.00000	0.00000	0.08574	0.00000	0.00000
100	20	12.04664	1.03149	7.20124	0.00000	0.00000	0.05433	0.09322	4.69784	0.00549	0.27652	0.00000	0.07937	0.67012	0.00000
100	40	6.48051	4.80373	0.44814	0.00000	0.00000	0.07618	0.11584	5.84035	0.08171	4.11939	0.00000	0.01868	0.58395	0.00000
100	60	3.50587	11.89687	0.01493	0.00000	0.00000	0.05337	0.06685	3.37072	0.22951	11.57231	0.00000	0.00496	0.09009	0.00000
100	80	6.46708	14.14938	0.04169	0.00000	0.00000	0.09217	0.12320	6.21002	0.27188	13.70437	0.00000	0.00727	0.16587	0.00000
100	100	20.79749	7.23028	1.48627	0.00000	0.00000	0.23072	0.37106	18.70945	0.12242	6.17280	0.00000	0.03214	0.90292	0.00000

Table A.23: Consumer Drift Scenario 3 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.14993	0.01780	0.03253	0.00000	0.00000	0.05872	0.05869	0.00000	0.00894	0.00000	0.00000	0.00001	0.00885	0.00000
1	20	1.97440	0.37794	0.01056	0.00000	0.00000	0.98214	0.98170	0.00000	0.37057	0.00000	0.00000	0.00001	0.00736	0.00000
1	40	3.90658	0.76217	0.01013	0.00000	0.00000	1.94892	1.94753	0.00000	0.75491	0.00000	0.00000	0.00001	0.00726	0.00000
1	60	5.96136	1.08598	0.01119	0.00000	0.00000	2.97643	2.97373	0.00000	1.07847	0.00000	0.00000	0.00001	0.00750	0.00000
1	80	7.89877	1.47235	0.01082	0.00000	0.00000	3.94482	3.94312	0.00000	1.46493	0.00000	0.00000	0.00001	0.00742	0.00000
1	100	9.71080	1.92260	0.00987	0.00000	0.00000	4.85115	4.84979	0.00000	1.91540	0.00000	0.00000	0.00001	0.00719	0.00000
20	1	3.55642	0.04199	1.85613	1.56902	0.00000	0.06582	0.06544	0.00000	0.00088	0.00000	0.00000	0.00051	0.02200	0.01860
20	20	2.97694	0.35984	0.63601	0.00000	0.00000	1.17077	1.17016	0.00000	0.18231	0.00000	0.00000	0.00028	0.17725	0.00000
20	40	4.66626	0.72112	0.36173	0.00000	0.00000	2.15302	2.15150	0.00000	0.55119	0.00000	0.00000	0.00021	0.16972	0.00000
20	60	6.57379	1.08652	0.30159	0.00000	0.00000	3.13667	3.13554	0.00000	0.92320	0.00000	0.00000	0.00019	0.16313	0.00000
20	80	8.56512	1.43272	0.28462	0.00000	0.00000	4.14085	4.13966	0.00000	1.27177	0.00000	0.00000	0.00019	0.16076	0.00000
20	100	10.69737	1.72354	0.29365	0.00000	0.00000	5.20300	5.20073	0.00000	1.56131	0.00000	0.00000	0.00019	0.16205	0.00000
40	1	6.96754	0.07495	3.71618	3.12994	0.00000	0.06160	0.05983	0.00000	0.00076	0.00000	0.00000	0.00101	0.03972	0.03345
40	20	7.88828	0.16877	3.60916	1.63975	0.00000	1.32074	1.31863	0.00000	0.02970	0.00000	0.00000	0.00101	0.09493	0.04313
40	40	5.95389	0.71967	1.27202	0.00000	0.00000	2.34155	2.34032	0.00000	0.36462	0.00000	0.00000	0.00056	0.35450	0.00000
40	60	7.38498	1.11687	0.80892	0.00000	0.00000	3.28883	3.28722	0.00000	0.77036	0.00000	0.00000	0.00044	0.34607	0.00000
40	80	9.33252	1.44225	0.72347	0.00000	0.00000	4.30604	4.30301	0.00000	1.10238	0.00000	0.00000	0.00042	0.33945	0.00000
40	100	11.11726	1.84423	0.61914	0.00000	0.00000	5.25006	5.24806	0.00000	1.51553	0.00000	0.00000	0.00039	0.32831	0.00000
60	1	10.22371	0.00152	5.62665	4.59489	0.00000	0.00168	0.00049	0.00000	0.00000	0.00000	0.00000	0.00152	0.00000	0.00000
60	20	11.52973	0.19676	5.48903	3.38814	0.00000	1.32708	1.32548	0.00000	0.02425	0.00000	0.00000	0.00152	0.10572	0.06526
60	40	8.17480	0.67672	3.19727	0.00000	0.00000	2.49027	2.48726	0.00000	0.21324	0.00000	0.00000	0.00112	0.46237	0.00000
60	60	8.92501	1.08050	1.90422	0.00000	0.00000	3.51134	3.50945	0.00000	0.54785	0.00000	0.00000	0.00083	0.53182	0.00000
60	80	10.59305	1.40402	1.52640	0.00000	0.00000	4.53533	4.53132	0.00000	0.87144	0.00000	0.00000	0.00074	0.53184	0.00000
60	100	12.16905	1.80017	1.21519	0.00000	0.00000	5.47930	5.47456	0.00000	1.28046	0.00000	0.00000	0.00066	0.51904	0.00000
80	1	13.64540	0.00200	7.50097	6.14441	0.00000	0.00002	0.00000	0.00000	0.00000	0.00000	0.00000	0.00200	0.00000	0.00000
80	20	14.76384	0.24378	7.33635	4.77185	0.00000	1.32845	1.32719	0.00000	0.02329	0.00000	0.00000	0.00203	0.13236	0.08609
80	40	15.77656	0.33754	7.21833	3.27949	0.00000	2.64148	2.63726	0.00000	0.05940	0.00000	0.00000	0.00203	0.18985	0.08626
80	60	10.43865	1.12843	3.20410	0.00000	0.00000	3.61798	3.61658	0.00000	0.44137	0.00000	0.00000	0.00126	0.68579	0.00000
80	80	11.90777	1.43935	2.54405	0.00000	0.00000	4.68309	4.68063	0.00000	0.72924	0.00000	0.00000	0.00111	0.70900	0.00000
80	100	13.65957	1.73553	2.20097	0.00000	0.00000	5.73369	5.72491	0.00000	1.02350	0.00000	0.00000	0.00103	0.71101	0.00000
100	1	16.97348	0.00232	9.37317	7.60031	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00232	0.00000	0.00000
100	20	17.93892	0.29365	9.17943	6.10140	0.00000	1.32945	1.32864	0.00000	0.02291	0.00000	0.00000	0.00254	0.16111	0.10709
100	40	19.73559	0.35133	9.12356	5.30895	0.00000	2.65291	2.65016	0.00000	0.05076	0.00000	0.00000	0.00254	0.18841	0.10963
100	60	20.02787	0.48631	8.93161	3.18287	0.00000	3.95763	3.95578	0.00000	0.10131	0.00000	0.00000	0.00254	0.28198	0.10049
100	80	13.05391	1.53973	3.54969	0.00000	0.00000	4.75265	4.75156	0.00000	0.66170	0.00000	0.00000	0.00147	0.87656	0.00000
100	100	14.99341	1.78045	3.25258	0.00000	0.00000	5.87152	5.86931	0.00000	0.89426	0.00000	0.00000	0.00140	0.88479	0.00000

Table A.24: Consumer Drift Scenario 4 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 0, \xi_{O_2} = 1$)

A.3 Digital Cameras

Price Offline	Consumer Offline	Consumer Online	Elasticity	Profit F_1	Profit F_2
0.1	61.80870	0.00119	-1.00086	0.00048	0.00003
0.12	49.88136	0.00172	-1.26330	0.99832	0.00005
0.14	39.88767	0.00247	-1.48629	1.59650	0.00007
0.16	31.91029	0.00353	-1.64324	1.91603	0.00011
0.18	25.78793	0.00499	-1.71021	2.06503	0.00016
0.2	21.24358	0.00703	-1.67322	2.12717	0.00023
0.22	17.96821	0.00983	-1.53619	2.16012	0.00033
0.24	15.66926	0.01368	-1.32342	2.19917	0.00048
0.26	14.09435	0.01898	-1.07311	2.26269	0.00068
0.28	13.03896	0.02624	-0.82446	2.35751	0.00096
0.3	12.34503	0.03621	-0.60651	2.48349	0.00135
0.32	11.89482	0.04993	-0.43415	2.63683	0.00189
0.34	11.60316	0.06891	-0.31065	2.81232	0.00263
0.36	11.40965	0.09534	-0.23295	3.00464	0.00365
0.38	11.27152	0.13257	-0.19682	3.20905	0.00504
0.4	11.15741	0.18593	-0.20139	3.42159	0.00696
0.42	11.04143	0.26444	-0.25484	3.63903	0.00960
0.44	10.89585	0.38499	-0.38868	3.85858	0.01325
0.46	10.67632	0.58485	-0.71885	4.07742	0.01833
0.48	10.26376	0.97818	-2.01610	4.29150	0.02548
0.5	3.06578	8.15319	-0.25217	4.48759	0.03574
0.52	3.03352	8.15412	-0.35367	4.53573	0.05083
0.54	2.98704	8.15381	-0.59881	4.57582	0.07400
0.56	2.91016	8.15379	-1.16490	4.60019	0.11243
0.58	2.75892	8.15410	-3.39774	4.58592	0.18804
0.6	0.00000	8.16160	-28.70146	3.26464	1.56750
0.62	0.00000	8.16158	-30.51866	3.26463	1.56750
0.64	0.00000	8.16157	-32.86148	3.26463	1.56750
0.66	0.00000	8.16157	-36.57991	3.26463	1.56750
0.68	0.00000	8.16157	-46.88265	3.26463	1.56750
0.7	0.00000	8.16157	-43.47251	3.26463	1.56750
0.72	0.00000	8.16157	-45.97491	3.26463	1.56750
0.74	0.00000	8.16157	-48.74647	3.26463	1.56750
0.76	0.00000	8.16157	-51.79717	3.26463	1.56750
0.78	0.00000	8.16157	-55.14767	3.26463	1.56750
0.8	0.00000	8.16157	-58.80873	3.26463	1.56750
0.82	0.00000	8.16157	-62.76172	3.26463	1.56750
0.84	0.00000	8.16157	-66.58666	3.26463	1.56750
0.86	0.00000	8.16157	-86.00000	3.26463	1.56750
0.88	0.00000	8.16157	NA	3.26463	1.56750
0.9	0.00000	8.16157	-1.00086	3.26463	1.56750

Table A.25: Elasticity Scenario α ($p_{O_1} = 0.5, p_{B_2} = 0.7, p_{O_2} = 0.6$)

Price Offline	Consumer Offline	Consumer Online	Elasticity	Profit F_1	Profit F_2
0.1	45.80439	0.00004	-1.35152	0.00001	1.51678
0.12	33.86952	0.00005	-1.86131	0.67741	1.51946
0.14	23.87221	0.00007	-2.48389	0.95491	1.52248
0.16	15.89370	0.00010	-3.29921	0.95365	1.52629
0.18	9.77153	0.00013	-4.51278	0.78176	1.53145
0.2	5.22790	0.00018	-3.40054	0.52284	1.53875
0.22	3.58961	0.00025	-3.84799	0.43083	1.71301
0.24	2.43884	0.00035	-4.26258	0.34154	1.84385
0.26	1.64856	0.00048	-4.62810	0.26391	1.94846
0.28	1.11395	0.00066	-5.04482	0.20071	2.05062
0.3	0.58208	0.00093	-22.50619	0.11669	2.92258
0.32	0.09880	0.00133	-7.77042	0.02213	3.00604
0.34	0.06084	0.00193	-4.83097	0.01518	3.01347
0.36	0.04655	0.00293	-3.06734	0.01298	3.03036
0.38	0.03940	0.00490	-3.25543	0.01250	3.07075
0.4	0.00136	0.04088	-33.77787	0.01267	3.87495
0.42	0.00010	0.04131	-21.70889	0.01242	3.87075
0.44	0.00002	0.04105	-21.86544	0.01232	3.87122
0.46	0.00001	0.04094	-22.69530	0.01229	3.87157
0.48	0.00000	0.04090	-23.81037	0.01227	3.87177
0.5	0.00000	0.04088	-25.10587	0.01227	3.87188
0.52	0.00000	0.04088	-26.54269	0.01226	3.87194
0.54	0.00000	0.04088	-28.10473	0.01226	3.87196
0.56	0.00000	0.04088	-29.78613	0.01226	3.87198
0.58	0.00000	0.04088	-31.58653	0.01226	3.87198
0.6	0.00000	0.04088	-33.50896	0.01226	3.87198
0.62	0.00000	0.04088	-35.55887	0.01226	3.87198
0.64	0.00000	0.04088	-37.74368	0.01226	3.87199
0.66	0.00000	0.04088	-40.07253	0.01226	3.87199
0.68	0.00000	0.04088	-42.55624	0.01226	3.87199
0.7	0.00000	0.04088	-45.20724	0.01226	3.87199
0.72	0.00000	0.04088	-48.03954	0.01226	3.87199
0.74	0.00000	0.04088	-51.06871	0.01226	3.87199
0.76	0.00000	0.04088	-54.31147	0.01226	3.87199
0.78	0.00000	0.04088	-57.78742	0.01226	3.87199
0.8	0.00000	0.04088	-61.50292	0.01226	3.87199
0.82	0.00000	0.04088	-65.43574	0.01226	3.87199
0.84	0.00000	0.04088	-69.22142	0.01226	3.87199
0.86	0.00000	0.04088	-86.00000	0.01226	3.87199
0.88	0.00000	0.04088	NA	0.01226	3.87199
0.9	0.00000	0.04088	-1.35152	0.01226	3.87199

Table A.26: Elasticity Scenario β ($p_{O_1} = 0.4, p_{B_2} = 0.2, p_{O_2} = 0.3$)

Profit	Price	Cons. Offline	Cons. Online	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
5E-04	0.1	61.8087	0.0011877	5.27E-08	50.52196	1.42E-11	3.13493372	3.143112	5.0086951	0.0004579	0.0007296	1.65E-07	6.13E-10	0	0
0.998	0.12	49.8814	0.0017219	5.27E-08	38.59518	1.34E-11	3.13490125	3.142906	5.0083669	0.0006638	0.0010578	2.54E-07	6.97E-10	0	0
1.596	0.14	39.8877	0.0024746	5.27E-08	28.60229	1.26E-11	3.13485332	3.1426158	5.0079044	0.000954	0.0015202	3.85E-07	7.84E-10	0	0
1.916	0.16	31.9103	0.0035282	5.27E-08	20.62604	1.18E-11	3.13478335	3.1422097	5.0072572	0.0013602	0.0021675	5.77E-07	8.74E-10	0	0
2.065	0.18	25.7879	0.0049946	5.27E-08	14.50525	1.09E-11	3.13468226	3.1416444	5.0063564	0.0019255	0.0030683	8.53E-07	9.65E-10	0	0
2.127	0.2	21.2436	0.0070257	5.27E-08	9.963072	1.00E-11	3.13453756	3.1408614	5.0051087	0.0027084	0.004316	1.25E-06	1.06E-09	0	0
2.16	0.22	17.9682	0.0098278	5.27E-08	6.690705	9.14E-12	3.13433217	3.1397812	5.0033873	0.0037886	0.0060374	1.81E-06	1.15E-09	0	0
2.199	0.24	15.6693	0.0136825	5.27E-08	4.395905	8.27E-12	3.13404278	3.1382952	5.0010194	0.0052746	0.0084053	2.60E-06	1.24E-09	0	0
2.263	0.26	14.0943	0.0189751	5.27E-08	2.826688	7.42E-12	3.13363772	3.136255	4.9977682	0.0073148	0.0116565	3.71E-06	1.33E-09	0	0
2.358	0.28	13.039	0.0262369	5.27E-08	1.779128	6.60E-12	3.13307397	3.1334556	4.9933072	0.0101142	0.0161175	5.25E-06	1.42E-09	0	0
2.483	0.3	12.345	0.0362079	5.27E-08	1.095946	5.81E-12	3.13229315	3.1296119	4.9871821	0.0139579	0.0222426	7.39E-06	1.50E-09	0	0
2.637	0.32	11.8948	0.0499316	5.27E-08	0.660532	5.05E-12	3.13121588	3.1243216	4.9787517	0.0192483	0.030673	1.03E-05	1.58E-09	0	0
2.812	0.34	11.6032	0.0689068	5.27E-08	0.389327	4.34E-12	3.12973398	3.1170068	4.9670953	0.026563	0.0423294	1.44E-05	1.66E-09	0	0
3.005	0.36	11.4096	0.0953371	5.27E-08	0.22427	3.68E-12	3.1276993	3.1068182	4.9508592	0.0367517	0.0585655	2.00E-05	1.73E-09	0	0
3.209	0.38	11.2715	0.1325707	5.27E-08	0.126157	3.07E-12	3.12490756	3.0924649	4.9279865	0.051105	0.0814382	2.76E-05	1.79E-09	0	0
3.422	0.4	11.1574	0.1859286	5.27E-08	0.069232	2.52E-12	3.12107435	3.0718956	4.8952085	0.0716742	0.1142162	3.81E-05	1.85E-09	0	0
3.639	0.42	11.0414	0.2644358	5.27E-08	0.037022	2.04E-12	3.11579842	3.0416309	4.8469803	0.1019389	0.1624444	5.25E-05	1.90E-09	0	0
3.859	0.44	10.8958	0.384988	5.27E-08	0.019266	1.61E-12	3.10850365	2.995157	4.772922	0.1484128	0.2365027	7.25E-05	1.95E-09	0	0
4.077	0.46	10.6763	0.584855	5.27E-08	0.009741	1.24E-12	3.09834276	2.9181045	4.6501353	0.2254653	0.3592894	0.0001	1.99E-09	0	0
4.292	0.48	10.2638	0.9781759	5.27E-08	0.004777	9.24E-13	3.08402862	2.7664659	4.4084921	0.3771039	0.6009326	0.000139	2.02E-09	0	0
4.488	0.5	3.06578	8.1531901	5.27E-08	0.002268	6.68E-13	3.06351547	0	0	3.1435698	5.0094247	0.000196	2.05E-09	0	0
4.536	0.52	3.03352	8.1541246	9.50E-09	0.000187	4.63E-13	3.03333337	0	0	3.1435698	5.0094247	0.000278	2.07E-09	4.3E-08	0.000852
4.576	0.54	2.98704	8.1538062	5.98E-09	5.21E-05	3.06E-13	2.98698625	0	0	3.1435698	5.0094247	0.000405	2.08E-09	4.7E-08	0.000407
4.6	0.56	2.91016	8.1537889	4.11E-09	1.52E-05	1.89E-13	2.91014396	0	0	3.1435698	5.0094247	0.000615	2.10E-09	4.9E-08	0.000179
4.586	0.58	2.75892	8.1540978	2.93E-09	4.39E-06	1.08E-13	2.75891901	0	0	3.1435698	5.0094247	0.001029	2.10E-09	5.0E-08	7.44E-05
3.265	0.6	1.24E-06	8.1615994	2.14E-09	1.23E-06	5.46E-14	0	0	0	3.1435698	5.0094247	0.008576	2.11E-09	5.1E-08	2.92E-05
3.265	0.62	3.32E-07	8.161581	2.84E-10	3.32E-07	2.36E-14	0	0	0	3.1435698	5.0094247	0.008576	2.11E-09	9.2E-09	1.08E-05
3.265	0.64	8.41E-08	8.1615739	1.33E-10	8.39E-08	7.84E-15	0	0	0	3.1435698	5.0094247	0.008576	2.11E-09	5.8E-09	3.68E-06
3.265	0.66	1.92E-08	8.1615713	6.84E-11	1.92E-08	1.63E-15	0	0	0	3.1435698	5.0094247	0.008576	2.12E-09	4.0E-09	1.13E-06
3.265	0.68	3.45E-09	8.1615705	3.66E-11	3.42E-09	1.07E-16	0	0	0	3.1435698	5.0094247	0.008576	2.12E-09	2.9E-09	2.70E-07
3.265	0.7	2.00E-11	8.1615702	2.00E-11	0	0	0	0	0	3.1435698	5.0094247	0.008576	2.12E-09	2.1E-09	0
3.265	0.72	2.81E-12	8.1615702	2.81E-12	0	0	0	0	0	3.1435698	5.0094247	0.008576	5.36E-10	4.0E-10	0
3.265	0.74	3.58E-13	8.1615702	3.58E-13	0	0	0	0	0	3.1435698	5.0094247	0.008576	1.22E-10	6.8E-11	0
3.265	0.76	4.03E-14	8.1615702	4.03E-14	0	0	0	0	0	3.1435698	5.0094247	0.008576	2.47E-11	1.0E-11	0
3.265	0.78	3.93E-15	8.1615702	3.93E-15	0	0	0	0	0	3.1435698	5.0094247	0.008576	4.31E-12	1.3E-12	0
3.265	0.8	3.21E-16	8.1615702	3.21E-16	0	0	0	0	0	3.1435698	5.0094247	0.008576	6.35E-13	1.5E-13	0
3.265	0.82	2.12E-17	8.1615702	2.12E-17	0	0	0	0	0	3.1435698	5.0094247	0.008576	7.61E-14	1.3E-14	0
3.265	0.84	1.09E-18	8.1615702	1.09E-18	0	0	0	0	0	3.1435698	5.0094247	0.008576	7.14E-15	9.3E-16	0
3.265	0.86	3.70E-20	8.1615702	3.70E-20	0	0	0	0	0	3.1435698	5.0094247	0.008576	4.46E-16	4.3E-17	0
3.265	0.88	0	8.1615702	0	0	0	0	0	0	3.1435698	5.0094247	0.008576	0	0	0
3.265	0.9	0	8.1615702	0	0	0	0	0	0	3.1435698	5.0094247	0.008576	0	0	0

Table A.27: Consumer Decomposition Scenario α ($p_{O_1} = 0.5, p_{B_2} = 0.7, p_{O_2} = 0.6$)

Profit	Price	Cons. Offline	Cons. Online	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1E-05	0.1	45.8044	3.52E-05	4.981536	40.55889	0.01359	0.209536	0.0408402	0	3.52E-05	0	0	0	0	0
0.677	0.12	33.8695	4.93E-05	4.981536	28.63211	0.00586	0.2091818	0.0408262	0	4.93E-05	0	0	0	0	0
0.955	0.14	23.8722	6.86E-05	4.981536	18.63922	0.00195	0.20869206	0.0408068	0	6.86E-05	0	0	0	0	0
0.954	0.16	15.8937	9.51E-05	4.981536	10.66297	0.000405	0.2080099	0.0407803	0	9.51E-05	0	0	0	0	0
0.782	0.18	9.77153	0.0001315	4.981536	4.54218	2.66E-05	0.20704891	0.0407439	0	0.0001315	0	0	0	0	0
0.523	0.2	5.2279	0.0001815	4.981536	0	0	0.20567174	0.0406939	0	0.0001815	0	0	0	0	0
0.431	0.22	3.58961	0.0002503	3.345335	0	0	0.20364544	0.0406251	0	0.0002503	0	0	0	0	0
0.342	0.24	2.43884	0.0003454	2.197774	0	0	0.20053388	0.04053	0	0.0003454	0	0	0	0	0
0.264	0.26	1.64856	0.0004779	1.412791	0	0	0.19537501	0.0403975	0	0.0004779	0	0	0	0	0
0.201	0.28	1.11395	0.0006645	0.888518	0	0	0.1852224	0.0402109	0	0.0006645	0	0	0	0	0
0.117	0.3	0.58208	0.000932	0.542133	0	0	0	0.0399434	0	0.000932	0	0	0	0	0
0.022	0.32	0.0988	0.0013255	0.059246	0	0	0	0.0395499	0	0.0013255	0	0	0	0	0
0.015	0.34	0.06084	0.0019298	0.021897	0	0	0	0.0389456	0	0.0019298	0	0	0	0	0
0.013	0.36	0.04655	0.0029317	0.00861	0	0	0	0.0379437	0	0.0029317	0	0	0	0	0
0.013	0.38	0.0394	0.0049034	0.003428	0	0	0	0.035972	0	0.0049034	0	0	0	0	0
0.013	0.4	0.00136	0.0408754	0.001357	0	0	0	0	0	0.0408754	0	0	0	0	0
0.012	0.42	9.54E-05	0.0413088	9.54E-05	0	0	0	0	0	0.0408754	0	0	0	0.00043	0
0.012	0.44	2.29E-05	0.041054	2.29E-05	0	0	0	0	0	0.0408754	0	0	0	0.00018	0
0.012	0.46	5.82E-06	0.0409443	5.82E-06	0	0	0	0	0	0.0408754	0	0	0	6.9E-05	0
0.012	0.48	1.49E-06	0.0409007	1.49E-06	0	0	0	0	0	0.0408754	0	0	0	2.5E-05	0
0.012	0.5	3.77E-07	0.0408843	3.77E-07	0	0	0	0	0	0.0408754	0	0	0	8.9E-06	0
0.012	0.52	9.27E-08	0.0408784	9.27E-08	0	0	0	0	0	0.0408754	0	0	0	3.0E-06	0
0.012	0.54	2.20E-08	0.0408764	2.20E-08	0	0	0	0	0	0.0408754	0	0	0	9.6E-07	0
0.012	0.56	5.00E-09	0.0408757	5.00E-09	0	0	0	0	0	0.0408754	0	0	0	2.9E-07	0
0.012	0.58	1.08E-09	0.0408755	1.08E-09	0	0	0	0	0	0.0408754	0	0	0	8.5E-08	0
0.012	0.6	2.21E-10	0.0408754	2.21E-10	0	0	0	0	0	0.0408754	0	0	0	2.3E-08	0
0.012	0.62	4.23E-11	0.0408754	4.23E-11	0	0	0	0	0	0.0408754	0	0	0	6.0E-09	0
0.012	0.64	7.56E-12	0.0408754	7.56E-12	0	0	0	0	0	0.0408754	0	0	0	1.4E-09	0
0.012	0.66	1.25E-12	0.0408754	1.25E-12	0	0	0	0	0	0.0408754	0	0	0	3.2E-10	0
0.012	0.68	1.88E-13	0.0408754	1.88E-13	0	0	0	0	0	0.0408754	0	0	0	6.4E-11	0
0.012	0.7	2.56E-14	0.0408754	2.56E-14	0	0	0	0	0	0.0408754	0	0	0	1.2E-11	0
0.012	0.72	3.11E-15	0.0408754	3.11E-15	0	0	0	0	0	0.0408754	0	0	0	1.9E-12	0
0.012	0.74	3.33E-16	0.0408754	3.33E-16	0	0	0	0	0	0.0408754	0	0	0	2.8E-13	0
0.012	0.76	3.08E-17	0.0408754	3.08E-17	0	0	0	0	0	0.0408754	0	0	0	3.6E-14	0
0.012	0.78	2.39E-18	0.0408754	2.39E-18	0	0	0	0	0	0.0408754	0	0	0	3.8E-15	0
0.012	0.8	1.52E-19	0.0408754	1.52E-19	0	0	0	0	0	0.0408754	0	0	0	3.4E-16	0
0.012	0.82	7.61E-21	0.0408754	7.61E-21	0	0	0	0	0	0.0408754	0	0	0	2.4E-17	0
0.012	0.84	2.88E-22	0.0408754	2.88E-22	0	0	0	0	0	0.0408754	0	0	0	1.3E-18	0
0.012	0.86	6.97E-24	0.0408754	6.97E-24	0	0	0	0	0	0.0408754	0	0	0	4.4E-20	0
0.012	0.88	0	0.0408754	0	0	0	0	0	0	0.0408754	0	0	0	0	0
0.012	0.9	0	0.0408754	0	0	0	0	0	0	0.0408754	0	0	0	0	0

Table A.28: Consumer Decomposition Scenario β ($p_{O_1} = 0.4, p_{B_2} = 0.2, p_{O_2} = 0.3$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.10006	0.28317	0.10001	0.33647	0.09010	0.47852	0.10933	0.30346	0.99997	0.99996	1	0	0.08765	0.07176
1	20	0.14330	0.23462	0.10001	0.33647	0.12145	4.82199	0.81447	1.45848	0.99990	0.99983	1	0	0.65425	0.34489
1	40	0.16220	0.23603	0.10001	0.33647	0.11147	9.39663	1.61475	2.84174	0.99980	0.99985	1	0	1.28470	0.67200
1	60	0.18984	0.23842	0.10001	0.33647	0.04701	13.83370	2.54234	4.44174	0.99953	0.99961	1	0	1.91818	1.05036
1	80	0.19296	0.23726	0.10001	0.33647	0.04688	18.57544	3.36343	5.86106	0.99959	0.99927	1	0	2.55225	1.38599
1	100	0.22514	0.23845	0.10001	0.33647	0.00263	23.01484	4.41901	7.68838	0.99960	0.99946	1	0	3.18539	1.81811
20	1	0.10005	0.31944	0.10001	0.33647	1.64003	6.25151	1.80469	5.61261	0.99995	0.99992	1	0	1.37181	1.32723
20	20	0.10006	0.28317	0.10001	0.33647	1.80206	9.57032	2.18659	6.06930	0.99997	0.99996	1	0	1.75308	1.43522
20	40	0.10014	0.25574	0.10001	0.33647	1.91788	14.62060	2.61066	6.61174	0.99991	0.99983	1	0	2.27577	1.56350
20	60	0.10012	0.24579	0.10001	0.33647	2.17073	19.46115	3.11822	7.42739	0.99995	0.99995	1	0	2.83704	1.75638
20	80	0.10026	0.23884	0.10001	0.33647	2.39325	24.54501	3.64907	8.29730	0.99995	0.99991	1	0	3.40779	1.96209
20	100	0.10036	0.23683	0.10001	0.33647	2.71774	29.13933	4.20699	9.25803	0.99995	0.99995	1	0	3.98762	2.18928
40	1	0.10009	0.33003	0.10001	0.33647	3.51674	11.86804	3.65513	11.40483	0.99992	0.99991	1	0	2.73001	2.69692
40	20	0.10009	0.30216	0.10001	0.33647	3.44069	15.12378	3.98357	11.69068	0.99997	0.99992	1	0	3.05760	2.76452
40	40	0.10006	0.28317	0.10001	0.33647	3.60411	19.14064	4.37317	12.13860	0.99997	0.99996	1	0	3.50616	2.87044
40	60	0.10012	0.26235	0.10001	0.33647	3.55575	24.73439	4.72806	12.46055	0.99996	0.99990	1	0	4.01511	2.94658
40	80	0.10014	0.25574	0.10001	0.33647	3.83575	29.24120	5.22133	13.22348	0.99991	0.99983	1	0	4.55155	3.12699
40	100	0.10014	0.25117	0.10001	0.33647	4.13531	33.79772	5.73470	14.05594	0.99994	0.99990	1	0	5.10808	3.32385
60	1	0.10009	0.32873	0.10001	0.33647	5.20889	17.87489	5.45697	17.04232	0.99994	0.99990	1	0	4.08843	4.03003
60	20	0.10007	0.30539	0.10001	0.33647	4.95301	21.39971	5.73173	17.16811	0.99996	0.99996	1	0	4.39543	4.05978
60	40	0.10008	0.28708	0.10001	0.33647	4.93263	25.64731	6.05267	17.39418	0.99995	0.99994	1	0	4.79815	4.11324
60	60	0.10006	0.28317	0.10001	0.33647	5.40617	28.71095	6.55976	18.20789	0.99997	0.99996	1	0	5.25924	4.30567
60	80	0.10011	0.27093	0.10001	0.33647	5.46902	33.71501	6.94384	18.62229	0.99994	0.99991	1	0	5.76266	4.40366
60	100	0.10015	0.26113	0.10001	0.33647	5.53299	39.03121	7.35622	19.12567	0.99990	0.99988	1	0	6.28673	4.52270
80	1	0.10008	0.32236	0.10001	0.33647	6.61078	24.48411	7.17960	22.43531	0.99998	0.99994	1	0	5.44477	5.30532
80	20	0.10009	0.31298	0.10001	0.33647	6.74668	26.95722	7.57611	22.94080	0.99991	0.99990	1	0	5.74097	5.42486
80	40	0.10009	0.30216	0.10001	0.33647	6.88139	30.24755	7.96713	23.38137	0.99997	0.99992	1	0	6.11520	5.52904
80	60	0.10006	0.28639	0.10001	0.33647	6.75398	35.13559	8.24352	23.48046	0.99997	0.99996	1	0	6.54918	5.55248
80	80	0.10006	0.28317	0.10001	0.33647	7.20823	38.28127	8.74635	24.27719	0.99997	0.99996	1	0	7.01232	5.74089
80	100	0.10007	0.27618	0.10001	0.33647	7.42021	42.62042	9.17291	24.83420	0.99998	0.99997	1	0	7.50901	5.87261
100	1	0.10008	0.31988	0.10001	0.33647	8.09791	30.90900	8.92180	27.89229	0.99996	0.99993	1	0	6.79650	6.59575
100	20	0.10008	0.31314	0.10001	0.33647	8.28689	33.27884	9.33272	28.43986	0.99998	0.99997	1	0	7.09371	6.72524
100	40	0.10006	0.30447	0.10001	0.33647	8.41953	36.44462	9.72071	28.88161	0.99997	0.99993	1	0	7.45191	6.82970
100	60	0.10013	0.29210	0.10001	0.33647	8.30827	40.86820	10.02053	29.02418	0.99989	0.99987	1	0	7.84657	6.86342
100	80	0.10007	0.28663	0.10001	0.33647	8.61404	44.46680	10.45189	29.61687	0.99997	0.99996	1	0	8.29936	7.00357
100	100	0.10006	0.28317	0.10001	0.33647	9.01028	47.85159	10.93294	30.34649	0.99997	0.99996	1	0	8.76540	7.17611

Table A.29: Scenario 1 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.10003	0.40331	0.15908	0.10001	0.22619	0.16620	0.00081	0.72307	1.00000	0.99999	1	0	0.05042	0.00006
1	20	0.25141	0.27790	0.15908	0.10001	0.01779	2.93153	0.00416	9.38242	0.99937	0.99931	1	0	0.52391	0.00034
1	40	0.24867	0.27602	0.15908	0.10001	0.04108	5.91296	0.00759	18.52500	0.99882	0.99868	1	0	1.04567	0.00063
1	60	0.31466	0.27655	0.15908	0.10001	0.06519	8.81578	1.13805	27.70818	0.97618	0.99625	1	0	1.56295	0.06752
1	80	0.23521	0.27770	0.15908	0.10001	0.08176	11.72118	0.00873	36.94310	0.99939	0.99945	1	0	2.09217	0.00089
1	100	0.27239	0.27758	0.15908	0.10001	0.07495	14.68101	0.02202	46.13845	0.99955	0.99960	1	0	2.61883	0.00176
20	1	0.10049	0.47194	0.15908	0.10001	5.14730	1.47121	0.01716	4.66017	0.99999	0.99999	1	0	0.54974	0.00106
20	20	0.10003	0.40331	0.15908	0.10001	4.52383	3.32400	0.01625	14.46135	1.00000	0.99999	1	0	1.00834	0.00110
20	40	0.10003	0.35403	0.15908	0.10001	4.36848	5.91354	0.01470	23.78455	1.00000	0.99999	1	0	1.50238	0.00111
20	60	0.10014	0.29803	0.15908	0.10001	3.77697	10.88037	0.01224	31.51610	0.99998	0.99998	1	0	2.15518	0.00104
20	80	0.10011	0.29987	0.15908	0.10001	4.47457	12.68611	0.01236	41.05609	0.99999	0.99999	1	0	2.53605	0.00114
20	100	0.10010	0.26230	0.15908	0.10001	3.67056	19.16787	0.01082	47.77117	0.99996	0.99994	1	0	3.11107	0.00112
40	1	0.10022	0.47515	0.15908	0.10001	10.45031	2.82628	0.03435	8.77487	1.00000	1.00000	1	0	1.06255	0.00212
40	20	0.10228	0.47241	0.15908	0.10001	10.23053	2.99276	0.03432	19.21753	0.99998	0.99998	1	0	1.13777	0.00222
40	40	0.10003	0.40331	0.15908	0.10001	9.04767	6.64801	0.03249	28.92271	1.00000	0.99999	1	0	2.01668	0.00221
40	60	0.10008	0.41674	0.15908	0.10001	10.10424	6.23542	0.03307	39.81533	1.00000	1.00000	1	0	1.97584	0.00235
40	80	0.10003	0.35403	0.15908	0.10001	8.73695	11.82709	0.02940	47.56909	1.00000	0.99999	1	0	3.00475	0.00221
40	100	0.10005	0.29964	0.15908	0.10001	7.01375	19.57299	0.02458	53.72585	0.99998	0.99998	1	0	3.90787	0.00199
60	1	0.10047	0.46978	0.15908	0.10001	15.30089	4.52057	0.05144	12.87693	0.99999	0.99999	1	0	1.67879	0.00317
60	20	0.10502	0.46715	0.15908	0.10001	13.94344	4.62184	0.05140	23.29192	0.99998	0.99997	1	0	1.76670	0.00327
60	40	0.10005	0.42864	0.15908	0.10001	14.26095	7.55053	0.05022	33.52904	0.99999	0.99999	1	0	2.48211	0.00330
60	60	0.10003	0.40331	0.15908	0.10001	13.57150	9.97201	0.04874	43.38406	1.00000	0.99999	1	0	3.02503	0.00331
60	80	0.10006	0.42957	0.15908	0.10001	15.43712	8.04886	0.05027	54.92413	0.99999	0.99999	1	0	2.65350	0.00352
60	100	0.10006	0.31598	0.15908	0.10001	10.00276	22.05232	0.03913	58.37816	0.99999	0.99999	1	0	4.76340	0.00290
80	1	0.10006	0.47490	0.15908	0.10001	20.94422	5.67092	0.06869	16.99806	1.00000	1.00000	1	0	2.12723	0.00423
80	20	0.10050	0.47380	0.15908	0.10001	21.01920	5.83834	0.06867	27.44864	0.99999	0.99999	1	0	2.19293	0.00433
80	40	0.10228	0.47241	0.15908	0.10001	20.46107	5.98553	0.06864	38.43507	0.99998	0.99998	1	0	2.27554	0.00444
80	60	0.10007	0.43031	0.15908	0.10001	19.30760	9.99498	0.06706	48.31784	0.99999	0.99999	1	0	3.30276	0.00445
80	80	0.10003	0.40331	0.15908	0.10001	18.09533	13.29601	0.06499	57.84542	1.00000	0.99999	1	0	4.03337	0.00442
80	100	0.10002	0.43144	0.15908	0.10001	20.52368	10.43367	0.06713	69.75615	1.00000	1.00000	1	0	3.45843	0.00466
100	1	0.10007	0.47504	0.15908	0.10001	26.18147	7.07419	0.08587	21.11041	1.00000	0.99999	1	0	2.65485	0.00528
100	20	0.10010	0.45033	0.15908	0.10001	24.42330	9.59038	0.08505	31.29997	1.00000	0.99999	1	0	3.36219	0.00534
100	40	0.10008	0.41703	0.15908	0.10001	21.92180	13.56135	0.08269	41.31703	0.99999	0.99999	1	0	4.30100	0.00530
100	60	0.10019	0.46617	0.15908	0.10001	26.57739	8.26838	0.08565	53.38636	1.00000	0.99999	1	0	3.03280	0.00559
100	80	0.10009	0.44516	0.15908	0.10001	25.46733	10.75022	0.08479	63.64005	0.99999	0.99999	1	0	3.71288	0.00565
100	100	0.10003	0.40331	0.15908	0.10001	22.61916	16.62002	0.08123	72.30677	1.00000	0.99999	1	0	5.04171	0.00552

Table A.30: Scenario 2 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.10016	0.24474	0.10001	0.33647	0.08457	0.28954	0.07401	0.10493	0.99997	0.99996	0	1	0.04192	0.02481
1	20	0.18656	0.25898	0.10001	0.33647	0.31926	4.21812	1.36168	1.79158	0.99989	0.99985	0	1	0.69804	0.42367
1	40	0.18914	0.25561	0.10001	0.33647	0.58947	8.62555	2.53547	3.34846	0.99983	0.99982	0	1	1.39382	0.79183
1	60	0.18980	0.25756	0.10001	0.33647	0.87951	12.77113	3.76048	4.90266	0.99985	0.99977	0	1	2.09016	1.15936
1	80	0.18593	0.25613	0.10001	0.33647	1.28898	17.15089	4.92633	6.45033	0.99964	0.99967	0	1	2.78446	1.52535
1	100	0.19045	0.25681	0.10001	0.33647	1.43725	21.39007	6.14337	8.01157	0.99981	0.99980	0	1	3.48181	1.89455
20	1	0.10010	0.31526	0.10001	0.33647	0.73676	1.41632	0.73551	1.10495	0.99989	0.99988	0	1	0.30487	0.26129
20	20	0.10024	0.24795	0.10001	0.33647	1.72226	5.66781	1.51174	2.12217	0.99995	0.99993	0	1	0.83882	0.50184
20	40	0.12704	0.24893	0.10001	0.33647	2.03101	9.45257	3.77461	5.40496	0.99994	0.99990	0	1	1.46242	1.27814
20	60	0.14959	0.24740	0.10001	0.33647	1.97718	13.86198	5.63318	8.09974	0.99994	0.99989	0	1	2.14088	1.91539
20	80	0.16055	0.25122	0.10001	0.33647	2.17191	17.86620	7.15388	10.11307	0.99983	0.99978	0	1	2.83171	2.39150
20	100	0.16420	0.25279	0.10001	0.33647	2.53015	22.01783	8.45647	11.81267	0.99990	0.99985	0	1	3.52532	2.79341
40	1	0.10004	0.31500	0.10001	0.33647	1.38704	2.73656	1.38373	2.12029	0.99998	0.99997	0	1	0.58841	0.50140
40	20	0.10009	0.26188	0.10001	0.33647	2.27722	6.71249	2.04499	2.83611	0.99997	0.99996	0	1	1.08681	0.67067
40	40	0.10024	0.24795	0.10001	0.33647	3.44452	11.33563	3.02349	4.24435	0.99995	0.99993	0	1	1.67763	1.00369
40	60	0.10238	0.24471	0.10001	0.33647	4.57349	15.68990	4.29201	6.06089	0.99990	0.99985	0	1	2.27972	1.43326
40	80	0.12704	0.24893	0.10001	0.33647	4.06202	18.90513	7.54922	10.80993	0.99994	0.99990	0	1	2.92483	2.55629
40	100	0.14633	0.24812	0.10001	0.33647	3.54149	23.19426	9.95299	14.35480	0.99995	0.99991	0	1	3.59923	3.39456
60	1	0.10003	0.32299	0.10001	0.33647	2.16522	3.91805	2.16478	3.33895	0.99999	0.99998	0	1	0.87374	0.78958
60	20	0.10012	0.27535	0.10001	0.33647	2.93083	7.67469	2.71069	3.74682	0.99993	0.99989	0	1	1.34572	0.88603
60	40	0.10015	0.26068	0.10001	0.33647	4.11497	11.95416	3.66057	5.02148	0.99996	0.99994	0	1	1.92129	1.18746
60	60	0.10026	0.24809	0.10001	0.33647	5.16951	16.98678	4.54132	6.37334	0.99998	0.99997	0	1	2.51681	1.50714
60	80	0.10065	0.24451	0.10001	0.33647	6.36743	21.55037	5.63254	7.94803	0.99992	0.99988	0	1	3.11737	1.87952
60	100	0.11180	0.24444	0.10001	0.33647	6.49015	25.35609	8.19546	11.74142	0.99969	0.99966	0	1	3.72775	2.77656
80	1	0.10003	0.32431	0.10001	0.33647	2.88598	5.16261	2.88790	4.47121	0.99998	0.99997	0	1	1.15813	1.05733
80	20	0.10008	0.29275	0.10001	0.33647	3.80112	8.35204	3.60315	4.95786	0.99996	0.99996	0	1	1.61003	1.17241
80	40	0.10009	0.26188	0.10001	0.33647	4.55444	13.42499	4.08999	5.67222	0.99997	0.99996	0	1	2.17362	1.34134
80	60	0.10015	0.25530	0.10001	0.33647	5.78341	17.76586	5.11150	7.08162	0.99993	0.99990	0	1	2.75914	1.67463
80	80	0.10024	0.24795	0.10001	0.33647	6.88904	22.67125	6.04697	8.48870	0.99995	0.99993	0	1	3.35526	2.00737
80	100	0.10057	0.24342	0.10001	0.33647	8.00121	27.54980	7.07539	10.03348	0.99996	0.99992	0	1	3.95494	2.37268
100	1	0.10006	0.32620	0.10001	0.33647	3.63372	6.37437	3.64482	5.65660	0.99995	0.99995	0	1	1.44200	1.33765
100	20	0.10007	0.29670	0.10001	0.33647	4.45384	9.57443	4.26686	5.95223	0.99997	0.99995	0	1	1.88349	1.40756
100	40	0.10011	0.26919	0.10001	0.33647	5.19930	14.36341	4.74293	6.55343	0.99995	0.99988	0	1	2.43017	1.54973
100	60	0.10008	0.26076	0.10001	0.33647	6.38364	18.71248	5.68076	7.82850	0.99998	0.99999	0	1	3.00862	1.85125
100	80	0.10017	0.25364	0.10001	0.33647	7.50738	23.41235	6.62132	9.19776	0.99999	0.99997	0	1	3.59841	2.17505
100	100	0.10027	0.25259	0.10001	0.33647	8.85036	27.46572	7.77533	10.75395	0.99998	0.99991	0	1	4.19297	2.54305

Table A.31: Scenario 3 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Cons. Off.	Cons. On.	Price Off. F_1	Price On. F_1	Price Off. F_2	Price On. F_2	Cons. Off. F_1	Cons. On. F_1	Cons. Off. F_2	Cons. On. F_2	Eff. Off. F_1	Eff. On. F_1	Eff. Off. F_2	Eff. On. F_2	Profit F_1	Profit F_2
1	1	0.10010	0.34137	0.15908	0.10001	0.10705	0.30838	0.01585	0.50893	0.88288	1.00000	0	1	0.07443	0.00094
1	20	0.66231	0.33558	0.15908	0.10001	0	2.45004	0.42532	10.05393	0.99170	0.98743	0	1	0.57649	0.02523
1	40	0.71083	0.33588	0.15908	0.10001	0.00065	4.89312	0.84707	19.90537	0.98942	0.98833	0	1	1.15286	0.05025
1	60	0.57936	0.33695	0.15908	0.10001	0.00035	7.30751	1.26823	29.78769	0.98497	0.98999	0	1	1.72930	0.07523
1	80	0.64751	0.33639	0.15908	0.10001	0.00005	9.76618	1.70114	39.62547	0.98926	0.98501	0	1	2.30578	0.10090
1	100	0.66360	0.33688	0.15908	0.10001	0.00017	12.18340	2.12648	49.50493	0.98742	0.98977	0	1	2.88223	0.12613
20	1	0.10005	0.38373	0.15908	0.10001	3.21929	2.84011	0.03774	1.25626	0.99995	0.99994	0	1	0.80591	0.00224
20	20	0.10007	0.33146	0.15908	0.10001	3.09779	5.35135	0.41832	10.27826	0.99995	0.99993	0	1	1.23872	0.02482
20	40	0.10010	0.29712	0.15908	0.10001	3.05314	8.64476	0.50760	19.18417	0.99996	0.99994	0	1	1.70425	0.03018
20	60	0.10009	0.29322	0.15908	0.10001	3.60673	11.10255	0.70803	28.45713	0.99999	0.99999	0	1	2.14556	0.04212
20	80	0.10010	0.30202	0.15908	0.10001	4.59722	12.61820	1.10143	38.27767	0.99999	0.99998	0	1	2.54957	0.06546
20	100	0.10018	0.28579	0.15908	0.10001	4.58036	16.39793	1.01918	46.74404	0.99999	0.99998	0	1	3.04737	0.06068
40	1	0.10003	0.46984	0.15908	0.10001	9.46026	2.52751	0.05494	3.10882	1.00000	1.00000	0	1	0.93510	0.00328
40	20	0.10003	0.40872	0.15908	0.10001	8.33355	5.36186	0.70717	12.30043	0.99999	0.99999	0	1	1.65556	0.04190
40	40	0.10007	0.33146	0.15908	0.10001	6.19559	10.70270	0.83663	20.55652	0.99995	0.99993	0	1	2.47744	0.04964
40	60	0.10004	0.32274	0.15908	0.10001	6.64844	13.02739	1.12497	30.00712	0.99998	0.99997	0	1	2.90196	0.06677
40	80	0.10010	0.29712	0.15908	0.10001	6.10629	17.28953	1.01520	38.36834	0.99996	0.99994	0	1	3.40850	0.06036
40	100	0.10008	0.33860	0.15908	0.10001	9.18298	14.81993	2.25015	50.40479	0.99998	0.99998	0	1	3.53665	0.13345
60	1	0.10008	0.46221	0.15908	0.10001	13.78363	4.15256	0.06506	4.23791	1.00000	0.99999	0	1	1.50517	0.00389
60	20	0.10019	0.46757	0.15908	0.10001	14.93051	4.17798	0.71026	14.75635	1.00000	1.00000	0	1	1.53851	0.04211
60	40	0.10007	0.39176	0.15908	0.10001	12.04319	9.66152	1.33067	23.12117	1.00000	0.99999	0	1	2.81966	0.07885
60	60	0.10007	0.33146	0.15908	0.10001	9.29338	16.05405	1.25495	30.83478	0.99995	0.99993	0	1	3.71616	0.07445
60	80	0.10124	0.46180	0.15908	0.10001	17.26995	5.46381	2.79583	47.36805	0.99999	0.99998	0	1	1.99822	0.16566
60	100	0.10008	0.29714	0.15908	0.10001	8.48700	23.74317	1.27078	48.12966	0.99996	0.99994	0	1	4.68110	0.07556
80	1	0.10007	0.38022	0.15908	0.10001	12.45790	11.47609	0.05498	3.39815	0.99999	0.99999	0	1	3.21667	0.00328
80	20	0.10012	0.47078	0.15908	0.10001	19.80751	5.25280	0.71473	16.12616	0.99999	0.99999	0	1	1.94999	0.04239
80	40	0.10003	0.40872	0.15908	0.10001	16.66711	10.72372	1.41435	24.60085	0.99999	0.99999	0	1	3.31112	0.08381
80	60	0.10003	0.40744	0.15908	0.10001	17.63221	11.55916	2.10003	35.06034	1.00000	0.99999	0	1	3.55428	0.12443
80	80	0.10007	0.33146	0.15908	0.10001	12.39117	21.40541	1.67327	41.11304	0.99995	0.99993	0	1	4.95488	0.09927
80	100	0.10008	0.31049	0.15908	0.10001	11.36566	26.05418	1.58309	49.42938	0.99997	0.99996	0	1	5.48479	0.09403
100	1	0.10004	0.34508	0.15908	0.10001	12.39661	17.52836	0.04622	3.18342	0.99998	0.99998	0	1	4.29626	0.00276
100	20	0.10012	0.46068	0.15908	0.10001	23.73719	7.35703	0.74164	17.01667	1.00000	0.99999	0	1	2.65636	0.04399
100	40	0.10152	0.47369	0.15908	0.10001	24.85695	6.46302	1.39138	28.52628	0.99999	0.99999	0	1	2.45307	0.08249
100	60	0.10340	0.47742	0.15908	0.10001	24.94051	6.33138	2.04693	39.72032	0.99999	0.99999	0	1	2.47443	0.12134
100	80	0.10045	0.47573	0.15908	0.10001	27.52518	6.87705	2.70130	50.64724	0.99999	0.99999	0	1	2.59634	0.16011
100	100	0.10007	0.33146	0.15908	0.10001	15.48897	26.75676	2.09158	51.39130	0.99995	0.99993	0	1	6.19360	0.12409

Table A.32: Scenario 4 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.09010	0.47851	0.05919	0	0	0.00000	0.01920	0.01172	0.07890	0.04817	0	0.17571	0.17573	0
1	20	0.12087	4.82228	0.01084	0	0	0.00001	0.05221	0.05780	2.18855	2.42290	0	0.10666	0.10418	0
1	40	0.11016	9.39749	0.00598	0	0	0.00003	0.04978	0.05438	4.41908	4.82702	0	0.07783	0.07357	0
1	60	0.03590	13.84193	0.00232	0	0	0.00004	0.01622	0.01732	6.65230	7.10104	0	0.04713	0.04146	0
1	80	0.03431	18.58477	0.00203	0	0	0.00005	0.01549	0.01673	8.89504	9.60646	0	0.04454	0.03873	0
1	100	0.00101	23.01409	0.00057	0	0	0.00007	0.00018	0.00019	11.11197	11.86067	0	0.02346	0.01800	0
20	1	1.63989	6.25162	1.60842	0	0	0.00000	0.02593	0.00554	0.05864	0.01252	0	3.08997	3.09050	0
20	20	1.80204	9.57027	1.18373	0	0	0.00001	0.38391	0.23438	1.57806	0.96341	0	3.51423	3.51457	0
20	40	1.91831	14.61996	0.90955	0	0	0.00003	0.53388	0.47486	3.73353	3.32079	0	3.78253	3.78312	0
20	60	2.17077	19.46098	0.82235	0	0	0.00004	0.67725	0.67112	5.88494	5.83168	0	3.87202	3.87234	0
20	80	2.39322	24.54477	0.76190	0	0	0.00005	0.79080	0.84047	8.09499	8.60349	0	3.92290	3.92339	0
20	100	2.71766	29.13921	0.74369	0	0	0.00007	0.94726	1.02665	10.20747	11.06306	0	3.93404	3.93464	0
40	1	3.51636	11.86847	3.48666	0	0	0.00000	0.02741	0.00229	0.05290	0.00442	0	5.90457	5.90657	0
40	20	3.44064	15.12376	2.79299	0	0	0.00001	0.45940	0.18823	1.36557	0.55953	0	6.59872	6.59994	0
40	40	3.60407	19.14055	2.36745	0	0	0.00003	0.76783	0.46876	3.15612	1.92683	0	7.02846	7.02915	0
40	60	3.55601	24.73400	1.94318	0	0	0.00004	0.88495	0.72784	5.40193	4.44293	0	7.44407	7.44506	0
40	80	3.83663	29.23992	1.81911	0	0	0.00005	1.06775	0.94971	7.46705	6.64158	0	7.56506	7.56623	0
40	100	4.13572	33.79691	1.73739	0	0	0.00007	1.23886	1.15941	9.55635	8.94348	0	7.64808	7.64899	0
60	1	5.20825	17.87569	5.17828	0	0	0.00000	0.02724	0.00273	0.05360	0.00536	0	8.90688	8.90986	0
60	20	4.95285	21.39976	4.30519	0	0	0.00001	0.47128	0.17637	1.32942	0.49752	0	9.78555	9.78727	0
60	40	4.93260	25.64725	3.67640	0	0	0.00003	0.80008	0.45609	3.06945	1.74975	0	10.41323	10.41483	0
60	60	5.40611	28.71082	3.55118	0	0	0.00004	1.15174	0.70315	4.73417	2.89024	0	10.54268	10.54372	0
60	80	5.46929	33.71466	3.16617	0	0	0.00005	1.32694	0.97613	6.84452	5.03498	0	10.91669	10.91847	0
60	100	5.53407	39.02987	2.87715	0	0	0.00007	1.44799	1.20886	9.06607	7.56885	0	11.19641	11.19855	0
80	1	6.61038	24.48427	6.57932	0	0	0.00000	0.02636	0.00470	0.05704	0.01018	0	12.20728	12.20977	0
80	20	6.74618	26.95818	6.10478	0	0	0.00001	0.49766	0.14372	1.24431	0.35935	0	12.67526	12.67926	0
80	40	6.88128	30.24752	5.58598	0	0	0.00003	0.91880	0.37647	2.73114	1.11906	0	13.19744	13.19988	0
80	60	6.75386	35.13550	4.87404	0	0	0.00004	1.19182	0.68795	4.62721	2.67095	0	13.91794	13.91941	0
80	80	7.20814	38.28109	4.73490	0	0	0.00005	1.53566	0.93753	6.31223	3.85365	0	14.05691	14.05830	0
80	100	7.42017	42.62028	4.43981	0	0	0.00007	1.77165	1.20865	8.27370	5.64444	0	14.35041	14.35174	0
100	1	8.09732	30.90937	8.06592	0	0	0.00000	0.02599	0.00541	0.05840	0.01216	0	15.41769	15.42111	0
100	20	8.28659	33.27885	7.64537	0	0	0.00001	0.49825	0.14296	1.24274	0.35657	0	15.83832	15.84122	0
100	40	8.41917	36.44465	7.12317	0	0	0.00003	0.93610	0.35987	2.67912	1.02995	0	16.36666	16.36892	0
100	60	8.30946	40.86848	6.39638	0	0	0.00004	1.26059	0.65245	4.43598	2.29596	0	17.06557	17.07097	0
100	80	8.61392	44.46668	6.10536	0	0	0.00005	1.59302	0.91548	6.15889	3.53940	0	17.38325	17.38516	0
100	100	9.01018	47.85137	5.91863	0	0	0.00007	1.91957	1.17191	7.89029	4.81707	0	17.57114	17.57287	0

Table A.33: Consumer Drift Scenario 1 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.22619	0.16620	0.01814	0.17516	0	0.00045	0.03245	0	0.02311	0	0	0.01027	0.01246	0.12036
1	20	0.01555	2.93346	0.00003	0.00000	0	0.01481	0.00071	0	2.93011	0	0	0.00248	0.00087	0.00000
1	40	0.03160	5.92272	0.00004	0.00000	0	0.02993	0.00163	0	5.91912	0	0	0.00264	0.00096	0.00000
1	60	0.00000	8.84230	0.00000	0.00000	0	0.00000	0.00000	0	8.84169	0	0	0.00055	0.00006	0.00000
1	80	0.07749	11.72529	0.00008	0.00000	0	0.06013	0.01728	0	11.72022	0	0	0.00353	0.00154	0.00000
1	100	0.07159	14.68461	0.00001	0.00000	0	0.07158	0.00001	0	14.68267	0	0	0.00154	0.00040	0.00000
20	1	5.14729	1.47121	0.48377	4.64374	0	0.00032	0.01945	0	0.00580	0	0	0.13182	0.12582	1.20777
20	20	4.52383	3.32400	0.36273	3.50316	0	0.00903	0.64891	0	0.46214	0	0	0.20536	0.24926	2.40725
20	40	4.36848	5.91354	0.26976	2.60525	0	0.02249	1.47098	0	2.01463	0	0	0.25152	0.34223	3.30516
20	60	3.77696	10.88036	0.17545	1.69207	0	0.04264	1.86681	0	5.94788	0	0	0.29223	0.43594	4.20432
20	80	4.47457	12.68610	0.17833	1.72054	0	0.05643	2.51927	0	7.78171	0	0	0.29111	0.43325	4.18004
20	100	3.67054	19.16789	0.12653	1.22111	0	0.08202	2.24088	0	13.69122	0	0	0.31117	0.48500	4.68050
40	1	10.45031	2.82628	0.98091	9.45023	0	0.00032	0.01885	0	0.00537	0	0	0.25669	0.24113	2.32308
40	20	10.23033	2.99283	0.94871	8.89000	0	0.00648	0.38515	0	0.11676	0	0	0.26262	0.25201	2.36145
40	40	9.04766	6.64800	0.72546	7.00631	0	0.01807	1.29782	0	0.92427	0	0	0.41072	0.49851	4.81450
40	60	10.10423	6.23542	0.77608	7.49010	0	0.02547	1.81258	0	1.08745	0	0	0.38296	0.44737	4.31764
40	80	8.73696	11.82707	0.53952	5.21051	0	0.04498	2.94196	0	4.02926	0	0	0.50304	0.68446	6.61032
40	100	7.01377	19.57294	0.35628	3.44003	0	0.07061	3.14686	0	9.74781	0	0	0.58250	0.86741	8.37522
60	1	15.30071	4.52064	1.44123	13.83928	0	0.00033	0.01987	0	0.00609	0	0	0.40247	0.38785	3.72424
60	20	13.94277	4.62206	1.35193	12.18229	0	0.00665	0.40189	0	0.13502	0	0	0.41106	0.40715	3.66884
60	40	14.26094	7.55053	1.23165	11.89218	0	0.01605	1.12106	0	0.57768	0	0	0.53660	0.60403	5.83222
60	60	13.57150	9.97201	1.08819	10.50947	0	0.02710	1.94673	0	1.38641	0	0	0.61608	0.74777	7.22175
60	80	15.43709	8.04886	1.23673	11.94051	0	0.03197	2.22788	0	1.13459	0	0	0.53361	0.59885	5.78181
60	100	10.00276	22.05229	0.61135	5.90254	0	0.06602	3.42286	0	8.16686	0	0	0.84198	1.22417	11.81928
80	1	20.94421	5.67092	1.96396	18.96103	0	0.00032	0.01890	0	0.00539	0	0	0.51445	0.48347	4.66762
80	20	21.01903	5.83840	1.94667	18.68412	0	0.00643	0.38181	0	0.11112	0	0	0.51920	0.49142	4.71666
80	40	20.46067	5.98567	1.89742	17.78000	0	0.01295	0.77030	0	0.23352	0	0	0.52523	0.50401	4.72291
80	60	19.30759	9.99497	1.65413	15.96723	0	0.02389	1.66234	0	0.83884	0	0	0.70831	0.79301	7.65482
80	80	18.09533	13.29601	1.45092	14.01263	0	0.03613	2.59564	0	1.84854	0	0	0.82144	0.99703	9.62901
80	100	20.52368	10.43367	1.66370	16.07087	0	0.03960	2.74950	0	1.36667	0	0	0.70346	0.78459	7.57894
100	1	26.18145	7.07419	2.45580	23.70645	0	0.00032	0.01888	0	0.00538	0	0	0.64230	0.60325	5.82328
100	20	24.42326	9.59039	2.24808	21.69281	0	0.00723	0.47513	0	0.18587	0	0	0.77686	0.81015	7.81751
100	40	21.92178	13.56135	1.94311	18.75533	0	0.01696	1.20638	0	0.72102	0	0	0.95589	1.11568	10.76877
100	60	26.57738	8.26838	2.38048	22.94108	0	0.02005	1.23576	0	0.39521	0	0	0.69043	0.67525	6.50749
100	80	25.46727	10.75024	2.20230	21.25204	0	0.02966	1.98327	0	0.82871	0	0	0.80507	0.85601	8.26045
100	100	22.61916	16.62001	1.81365	17.51578	0	0.04517	3.24456	0	2.31068	0	0	1.02680	1.24628	12.03626

Table A.34: Consumer Drift Scenario 2 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 1, \xi_{O_2} = 0$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.08456	0.28953	0.01699	0	0	0.04417	0.01231	0.01109	0.10968	0.09874	0	0.00000	0.08111	0
1	20	0.31863	4.21828	0.00087	0	0	0.27347	0.02542	0.01887	2.41437	1.79303	0	0.00000	0.01089	0
1	40	0.58708	8.62597	0.00074	0	0	0.51974	0.03743	0.02917	4.84213	3.77367	0	0.00000	0.01017	0
1	60	0.87597	12.77221	0.00074	0	0	0.76940	0.06020	0.04563	7.25914	5.50311	0	0.00000	0.00996	0
1	80	1.26850	17.15890	0.00086	0	0	1.10616	0.09104	0.07044	9.66808	7.47972	0	0.00000	0.01110	0
1	100	1.43063	21.39166	0.00071	0	0	1.26558	0.09304	0.07129	12.10586	9.27601	0	0.00000	0.00979	0
20	1	0.73655	1.41619	0.64998	0	0	0.04419	0.03574	0.00663	0.08625	0.01600	0	0.00001	1.31393	0
20	20	1.72219	5.66755	0.35042	0	0	0.88279	0.26231	0.22668	2.17747	1.88168	0	0.00001	1.60839	0
20	40	2.02995	9.45231	0.14914	0	0	1.33866	0.29256	0.24959	4.58700	3.91333	0	0.00000	0.95198	0
20	60	1.97596	13.86197	0.06526	0	0	1.50899	0.21478	0.18693	7.10456	6.18339	0	0.00000	0.57402	0
20	80	2.16429	17.86786	0.04498	0	0	1.71367	0.22194	0.18370	9.53718	7.89411	0	0.00000	0.43657	0
20	100	2.52803	22.01725	0.03981	0	0	2.02427	0.25628	0.20766	11.94262	9.67711	0	0.00000	0.39752	0
40	1	1.38686	2.73624	1.30029	0	0	0.04422	0.03565	0.00670	0.08633	0.01622	0	0.00001	2.63367	0
40	20	2.27713	6.71222	0.80993	0	0	0.88405	0.34074	0.24241	2.09904	1.49333	0	0.00001	3.11984	0
40	40	3.44438	11.33510	0.70083	0	0	1.76558	0.52462	0.45335	4.35494	3.76336	0	0.00001	3.21679	0
40	60	4.57185	15.68702	0.63469	0	0	2.59586	0.70573	0.63556	6.61361	5.95603	0	0.00001	3.11737	0
40	80	4.05990	18.90462	0.29828	0	0	2.67731	0.58512	0.49919	9.17400	7.82665	0	0.00001	1.90396	0
40	100	3.53970	23.19427	0.14867	0	0	2.63000	0.40868	0.35235	11.79022	10.16526	0	0.00001	1.23878	0
60	1	2.16483	3.91734	2.07727	0	0	0.04423	0.03881	0.00452	0.08316	0.00969	0	0.00002	3.82448	0
60	20	2.93053	7.67385	1.38000	0	0	0.88370	0.42466	0.24217	2.01512	1.14916	0	0.00002	4.50956	0
60	40	4.11479	11.95342	1.19829	0	0	1.76705	0.66659	0.48286	4.21297	3.05173	0	0.00002	4.68871	0
60	60	5.16937	16.98639	1.05236	0	0	2.64803	0.78868	0.68030	6.53066	5.63327	0	0.00002	4.82244	0
60	80	6.36698	21.54886	1.00166	0	0	3.51755	0.97103	0.87674	8.78809	7.93476	0	0.00002	4.82600	0
60	100	6.46085	25.33043	0.70476	0	0	3.94437	0.95170	0.86002	11.24720	10.16374	0	0.00001	3.91947	0
80	1	2.88547	5.16175	2.79778	0	0	0.04423	0.03934	0.00412	0.08263	0.00866	0	0.00002	5.07044	0
80	20	3.80076	8.35115	2.15594	0	0	0.88410	0.54471	0.21601	1.89507	0.75152	0	0.00002	5.70453	0
80	40	4.55427	13.42445	1.61986	0	0	1.76811	0.68147	0.48482	4.19809	2.98666	0	0.00002	6.23967	0
80	60	5.78302	17.76432	1.51437	0	0	2.65046	0.90772	0.71047	6.41162	5.01838	0	0.00002	6.33429	0
80	80	6.88875	22.67020	1.40167	0	0	3.53115	1.04923	0.90670	8.70989	7.52672	0	0.00002	6.43357	0
80	100	8.00072	27.54872	1.32406	0	0	4.40060	1.18835	1.08771	11.01055	10.07808	0	0.00002	6.46007	0
100	1	3.63300	6.37352	3.54516	0	0	0.04421	0.04009	0.00354	0.08187	0.00723	0	0.00003	6.28439	0
100	20	4.45339	9.57338	2.78997	0	0	0.88421	0.57360	0.20560	1.86618	0.66891	0	0.00003	7.03826	0
100	40	5.19881	14.36188	2.17165	0	0	1.76770	0.77076	0.48869	4.10880	2.60514	0	0.00003	7.64791	0
100	60	6.38337	18.71142	2.00334	0	0	2.65250	1.00231	0.72521	6.31703	4.57061	0	0.00003	7.82375	0
100	80	7.50715	23.41158	1.86148	0	0	3.53378	1.17269	0.93920	8.58644	6.87683	0	0.00003	7.94830	0
100	100	8.84995	27.46428	1.83623	0	0	4.41308	1.43479	1.16585	10.76411	8.74648	0	0.00003	7.95366	0

Table A.35: Consumer Drift Scenario 3 ($p_{B_2} = 0.10001, p_{O_2} = \tilde{p_{O_2}}, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Cons. Off.	Cons On.	Cons. Off. F_1	Cons. On. F_1	N-S Offline	N-S Ex. Offline	Off. F_2 Off. F_1	On. F_2 Off. F_1	On. F_1 Off. F_1	On. Ex. F_1 Off. F_1	N-S Online	N-S Ex. Online	On. F_2 On. F_1	Off. F_2 On. F_1	Off. F_1 On. F_1	Off. Ex. F_1 On. F_1
1	1	0.10703	0.30839	0.00020	0.07080	0	0	0.03603	0	0.08345	0	0	0.00000	0.00063	0.22431
1	20	0.00000	2.44898	0.00000	0.00000	0	0	0.00000	0	2.44898	0	0	0.00000	0.00000	0.00000
1	40	0.00000	4.89182	0.00000	0.00000	0	0	0.00000	0	4.89182	0	0	0.00000	0.00000	0.00000
1	60	0.00000	7.30455	0.00000	0.00000	0	0	0.00000	0	7.30455	0	0	0.00000	0.00000	0.00000
1	80	0.00000	9.76242	0.00000	0.00000	0	0	0.00000	0	9.76242	0	0	0.00000	0.00000	0.00000
1	100	0.00000	12.17783	0.00000	0.00000	0	0	0.00000	0	12.17783	0	0	0.00000	0.00000	0.00000
20	1	3.21926	2.84013	0.02767	3.13982	0	0	0.05177	0	0.04756	0	0	0.00000	0.02439	2.76818
20	20	3.09778	5.35131	0.01953	2.21587	0	0	0.86237	0	1.62954	0	0	0.00000	0.03252	3.68925
20	40	3.05311	8.64469	0.01482	1.68095	0	0	1.35734	0	4.38674	0	0	0.00000	0.03721	4.22074
20	60	3.60672	11.10255	0.01434	1.62600	0	0	1.96638	0	6.78734	0	0	0.00000	0.03772	4.27749
20	80	4.59722	12.61817	0.01546	1.75287	0	0	2.82890	0	8.43210	0	0	0.00000	0.03659	4.14949
20	100	4.58034	16.39788	0.01339	1.51849	0	0	3.04845	0	11.98564	0	0	0.00000	0.03858	4.37367
40	1	9.46026	2.52751	0.08225	9.32962	0	0	0.04839	0	0.01473	0	0	0.00000	0.02196	2.49082
40	20	8.33355	5.36186	0.06353	7.20703	0	0	1.06299	0	0.70609	0	0	0.00000	0.04068	4.61508
40	40	6.19555	10.70261	0.03906	4.43175	0	0	1.72475	0	3.25908	0	0	0.00000	0.06503	7.37850
40	60	6.64844	13.02737	0.03659	4.15123	0	0	2.46062	0	5.29308	0	0	0.00000	0.06758	7.66671
40	80	6.10621	17.28937	0.02964	3.36190	0	0	2.71468	0	8.77348	0	0	0.00000	0.07441	8.44148
40	100	9.18299	14.81988	0.04118	4.67047	0	0	4.47134	0	7.61817	0	0	0.00000	0.06294	7.13877
60	1	13.78362	4.15256	0.12004	13.61401	0	0	0.04957	0	0.01665	0	0	0.00000	0.03615	4.09976
60	20	14.93050	4.17798	0.12204	13.83378	0	0	0.97468	0	0.30611	0	0	0.00000	0.03386	3.83801
60	40	12.04318	9.66152	0.08693	9.85971	0	0	2.09654	0	1.73451	0	0	0.00000	0.06928	7.85774
60	60	9.29333	16.05392	0.05859	6.64762	0	0	2.58712	0	4.88862	0	0	0.00000	0.09755	11.06775
60	80	17.26986	5.46383	0.11703	13.19785	0	0	3.95498	0	1.35580	0	0	0.00000	0.03611	4.07192
60	100	8.48688	23.74305	0.04449	5.04747	0	0	3.39492	0	10.96422	0	0	0.00000	0.11165	12.66718
80	1	12.45788	11.47610	0.10843	12.29803	0	0	0.05142	0	0.04948	0	0	0.00000	0.09986	11.32676
80	20	19.80743	5.25282	0.16472	18.67826	0	0	0.96445	0	0.29038	0	0	0.00000	0.04338	4.91907
80	40	16.66711	10.72372	0.12706	14.41407	0	0	2.12598	0	1.41219	0	0	0.00000	0.08136	9.23017
80	60	17.63221	11.55916	0.12622	14.31848	0	0	3.18751	0	2.15256	0	0	0.00000	0.08220	9.32440
80	80	12.39111	21.40523	0.07812	8.86349	0	0	3.44949	0	6.51816	0	0	0.00000	0.13006	14.75700
80	100	11.36555	26.05410	0.06632	7.52330	0	0	3.77594	0	9.81981	0	0	0.00000	0.14186	16.09243
100	1	12.39654	17.52842	0.10792	12.24255	0	0	0.04608	0	0.07153	0	0	0.00000	0.15254	17.30435
100	20	23.73717	7.35703	0.19881	22.54282	0	0	0.99554	0	0.34127	0	0	0.00000	0.06133	6.95443
100	40	24.85693	6.46303	0.20206	22.75354	0	0	1.90133	0	0.56147	0	0	0.00000	0.05195	5.84961
100	60	24.94035	6.33143	0.19686	21.94577	0	0	2.79772	0	0.80665	0	0	0.00000	0.04912	5.47566
100	80	27.52511	6.87707	0.20785	23.53113	0	0	3.78612	0	1.07407	0	0	0.00000	0.05081	5.75219
100	100	15.48889	26.75653	0.09765	11.07937	0	0	4.31187	0	8.14770	0	0	0.00000	0.16258	18.44625

Table A.36: Consumer Drift Scenario 4 ($p_{B_2} = \tilde{p_{B_2}}, p_{O_2} = 0.10001, \xi_{B_2} = 0, \xi_{O_2} = 1$)

Appendix B

Questionnaire

B.1 Internet Usage

1. Wo nutzen Sie das Internet?
   ☐ zu Hause
   ☐ Büro / Arbeit
   ☐ Schule / Universität
   ☐ an öffentlichen Orten (z.B. Internet-Cafe)
   ☐ unterwegs
   ☐ nie

2. Wie würden Sie Ihren Internetzugang beschreiben?
   ☐ Schmalband (Telefonmodem, ISDN, ...)
   ☐ Breitband (Kabelmodem, ADSL, ...)
   ☐ keinen

3. Wie viel Zeit sind Sie pro Tag etwa online?
   ☐ 0-15 Minuten
   ☐ 16-59 Minuten
   ☐ 1-2 Stunden
   ☐ 2-4 Stunden
   ☐ 4 und mehr Stunden

4. Wie oft haben Sie im letzten Jahr im Internet eingekauft?
   ☐ noch nie
   ☐ 1-5 Mal
   ☐ 6-10 Mal
   ☐ 11-20 Mal
   ☐ 21 Mal und öfter

B.2 Shopping Behaviour

5. Wie viel Zeit verwenden Sie durchschnittlich unter der Woche für das Einkaufen (Samstag und Sonntag ausgenommen), sowohl im traditionellen Handel als auch online (Lebensmittel ausgenommen)?
   ☐ 0-15 Minuten
   ☐ 16-59 Minuten
   ☐ 1-2 Stunden
   ☐ 2-4 Stunden
   ☐ 4 und mehr Stunden

6. Wie viel Zeit verwenden Sie durchschnittlich am Wochenende (nur Samstag und Sonntag) für das Einkaufen im traditionellen Handel und online (Lebensmittel ausgenommen)?
   ☐ 0-15 Minuten
   ☐ 16-59 Minuten
   ☐ 1-2 Stunden
   ☐ 2-4 Stunden
   ☐ 4 und mehr Stunden

7. Wie hoch schätzen Sie Ihre verfügbare Freizeit unter der Woche (ohne Samstage und Sonntage) ein, d.h. alle freie Zeit, die zum Einkauf genutzt werden kann?
   ☐ 0-1 Stunde
   ☐ 2-5 Stunden
   ☐ 6-10 Stunden

☐ 11-20 Stunden
☐ 21 und mehr Stunden

8. Wie hoch schätzen Sie Ihre verfügbare Freizeit am Wochenende (nur Samstag und Sonntag) ein, d.h. alle freie Zeit, die zum Einkauf genutzt werden kann?
☐ 0-1 Stunde
☐ 2-5 Stunden
☐ 6-10 Stunden
☐ 11-20 Stunden
☐ 21 und mehr Stunden

9. Wo haben Sie bereits folgende Produkte gekauft?

	stationärer Handel	Onlineshop	stationärer Handel und Onlineshop	nie
Bücher	☐	☐	☐	☐
Kleidung	☐	☐	☐	☐
Parfums	☐	☐	☐	☐
Versicherungen	☐	☐	☐	☐
Digitalkamera	☐	☐	☐	☐
Urlaubsreisen	☐	☐	☐	☐
Schmuck / Uhren	☐	☐	☐	☐

B.3 Personality Traits

10. Nun folgen einige Fragen zu Ihrer Persönlichkeit. Bitte beachten Sie, dass es bei diesen Fragen kein Richtig oder Falsch gibt. Versuchen Sie spontan

zu antworten.

	trifft überhaupt nicht zu				trifft voll zu
Ich bin eher ruhig, reserviert	☐	☐	☐	☐	☐
Ich bin begeisterungsfähig und kann andere leicht mitreißen	☐	☐	☐	☐	☐
Ich bin eher der ”stille Typ”, zurückhaltend	☐	☐	☐	☐	☐
Ich gehe aus mir heraus, bin gesellig	☐	☐	☐	☐	☐
Ich erledige Aufgaben gründlich	☐	☐	☐	☐	☐
Ich bin bequem, neige zur Faulheit	☐	☐	☐	☐	☐
Ich bin tüchtig und arbeite flott	☐	☐	☐	☐	☐
Ich habe nur wenig künstlerisches Interesse	☐	☐	☐	☐	☐
Ich werde leicht deprimiert, niedergeschlagen	☐	☐	☐	☐	☐
Ich bin entspannt, lasse mich durch Stress nicht aus der Ruhe bringen	☐	☐	☐	☐	☐
Ich mache mir viele Sorgen	☐	☐	☐	☐	☐
Ich werde leicht nervös und unsicher	☐	☐	☐	☐	☐
Ich bin vielseitig interessiert	☐	☐	☐	☐	☐
Ich bin tiefsinnig, denke gerne über Sachen nach	☐	☐	☐	☐	☐
Ich habe eine aktive Vorstellungskraft, bin phantasievoll	☐	☐	☐	☐	☐
Ich schätze künstlerische und ästhetische Eindrücke	☐	☐	☐	☐	☐
Ich kann mich unzugänglich und distanziert verhalten	☐	☐	☐	☐	☐
Ich neige dazu, andere zu kritisieren	☐	☐	☐	☐	☐
Ich schenke anderen leicht Vertrauen, glaube an das Gute im Menschen	☐	☐	☐	☐	☐
Ich mache Pläne und führe sie auch durch	☐	☐	☐	☐	☐
Ich kann mich schroff und abweisend anderen gegenüber verhalten	☐	☐	☐	☐	☐

B.4 Purchase Behavior

The following questions will be asked for each product individually. Therefore, only the “Book”-questions are presented.

11. Wie viel geben Sie typischerweise bei einem einzelnen Kauf von Büchern inklusive der Lieferkosten aus (in ganzen Euro)?
    Texteingabe

12. Wie oft kaufen Sie Bücher im Jahr?
    ☐ 0-2 Mal
    ☐ 3-5 Mal
    ☐ 6-10 Mal
    ☐ 11-20 Mal
    ☐ 21 Mal und öfter

13. Wann haben Sie das letzte Mal Bücher gekauft?
    ☐ heute
    ☐ gestern
    ☐ innerhalb der letzten drei Tage
    ☐ innerhalb der letzten Woche
    ☐ innerhalb des letzten Monats
    ☐ innerhalb des letzten halben Jahres
    ☐ vor mehr als einem halben Jahr

14. Bewerten Sie bitte folgende Fragen zum Kauf von Büchern (um . . . Preis).

	trifft überhaupt nicht zu				trifft voll zu
Wenn ich Bücher kaufe, ist die Marke für mich wichtig	☐	☐	☐	☐	☐
Ich kann die Qualität von Büchern anhand der Informationen aus dem Internet bestimmen	☐	☐	☐	☐	☐
Die Informationen aus dem Internet sind ausreichend, wenn ich Bücher kaufe	☐	☐	☐	☐	☐
Attribute (z.B.: Fühlen, Riechen, Struktur), die ich nicht via Internet prüfen kann, sind beim Kauf von Büchern wichtig	☐	☐	☐	☐	☐
Ich fühle einen großen Unterschied zum traditionellen Handel, wenn ich Bücher im Internet kaufe	☐	☐	☐	☐	☐
Bücher sind mir wichtig	☐	☐	☐	☐	☐
Bücher bedeuten mir im Vergleich zu anderen Produkten sehr viel	☐	☐	☐	☐	☐

15. Welche Aussagen gelten typischerweise für den Einkauf von Büchern (um . . . Preis)?

	trifft überhaupt nicht zu				trifft voll zu
Qualität ist das Wichtigste	☐	☐	☐	☐	☐
langfristige Anlage (Investition)	☐	☐	☐	☐	☐
vor dem Kauf erschöpfende Informationssuche notwendig	☐	☐	☐	☐	☐
zum Kauf Beratung von Verkäufern notwendig	☐	☐	☐	☐	☐
Bücher braucht man	☐	☐	☐	☐	☐
kaufe immer das Gleiche, ohne zu Suchen	☐	☐	☐	☐	☐
geringer Preis	☐	☐	☐	☐	☐
längere Suche und Vergleich	☐	☐	☐	☐	☐
gezielter Einkauf	☐	☐	☐	☐	☐
Bücher nehme ich einfach mit	☐	☐	☐	☐	☐
Bücher dürfen auch etwas mehr kosten	☐	☐	☐	☐	☐
Kauf von Büchern macht Spaß	☐	☐	☐	☐	☐
Bücher braucht man nicht wirklich	☐	☐	☐	☐	☐
Bücher kaufe ich, um mich selbst zu belohnen	☐	☐	☐	☐	☐
üblicherweise sehr teuer	☐	☐	☐	☐	☐
Kauf von Büchern geht schnell und einfach vor sich	☐	☐	☐	☐	☐
zum Kauf Empfehlungen von Freunden / Bekannten notwendig	☐	☐	☐	☐	☐

16. Wichtig beim Kauf von Büchern (um … Preis) ist

	trifft überhaupt nicht zu				trifft voll zu
Bequemlichkeit	☐	☐	☐	☐	☐
Eine hohe Anzahl von Alternativen (große Auswahl)	☐	☐	☐	☐	☐
Entspannung	☐	☐	☐	☐	☐
Preis des Produkts	☐	☐	☐	☐	☐
Marke	☐	☐	☐	☐	☐
Kosten des Einkaufs (inklusive Fahrtkosten etc.)	☐	☐	☐	☐	☐
Qualitätsprüfung vor Ort durch mich	☐	☐	☐	☐	☐
Schnelligkeit der Auswahl	☐	☐	☐	☐	☐
Symbolik des Produkts (”Was will ich damit ausdrücken?”)	☐	☐	☐	☐	☐
Service (beispielsweise Rückgabemöglichkeiten)	☐	☐	☐	☐	☐
Zahlungsmöglichkeiten	☐	☐	☐	☐	☐
Eigene Erfahrungen mit dem Produkt	☐	☐	☐	☐	☐
Eigene Erfahrungen mit dem Geschäft / Onlineshop	☐	☐	☐	☐	☐
Beratung durch Verkäufer / Berater	☐	☐	☐	☐	☐
Name des Geschäfts / Onlineshops	☐	☐	☐	☐	☐
Anonymität	☐	☐	☐	☐	☐
Spaß / Unterhaltung beim Einkauf	☐	☐	☐	☐	☐
Sicherheit	☐	☐	☐	☐	☐
Darüber denke ich nicht nach	☐	☐	☐	☐	☐

17. Warum haben Sie sich entschieden, Bücher (um … Preis) im Internet anstatt im traditionellen Handel zu kaufen?

Texteingabe

18. Reihen Sie folgende Attribute nach ihrer Wichtigkeit, weswegen Sie Bücher (um ... Preis) im Internet gekauft haben
    ☐ Lieferzeit
    ☐ Bequemlichkeit (Bestellung von zu Hause, Lieferung)
    ☐ Benutzerfreundlichkeit (Navigation, Ladezeiten) der Website
    ☐ Lieferungsoptionen (Ort, Versicherung)
    ☐ Suche / Information (Vielfalt, Genauigkeit)
    ☐ Sicherheit (Zahlung)
    ☐ Privatsphäre / Anonymität
    ☐ Bekanntheitsgrad der Website / des Onlinehändlers
    ☐ Interaktivität (Forum, FAQ-Listen und andere Auswahlhilfen)
    ☐ Rückgabemöglichkeiten
    ☐ Qualität des Produkts
    ☐ Größe der Produktauswahl
    ☐ Klientel, soziale Einkaufsgruppe (Wer kauft dort sonst noch ein?)

19. Reihen Sie folgende Attribute nach ihrer Wichtigkeit, falls Sie Bücher (um ... Preis) im traditionellen Handel kaufen würden
    ☐ Verfügbarkeit, sofortige Mitnahmemöglichkeit
    ☐ Bekanntheitsgrad des Geschäfts / des Händlers
    ☐ Atmosphäre im Shop
    ☐ Beratung durch Personal
    ☐ Größe der Produktauswahl
    ☐ Bequemlichkeit (Parkmöglichkeiten, Erreichbarkeit)
    ☐ Service (Lieferung, Rückgabemöglichkeiten)
    ☐ Klientel, soziale Einkaufsgruppe (Gesellschaftsschicht der anderen Kunden)
    ☐ Qualität des Produkts
    ☐ Sicherheit (Zahlung)
    ☐ Privatsphäre
    ☐ Prüfungsmöglichkeit vor dem Kauf (Fühlen; Riechen; Sehen; Anprobieren; ich weiß, was ich bekomme)

20. Welchen Preis dürfen Bücher (um . . . Preis im Internet) im traditionellen Handel haben, damit Sie dort kaufen?
    Texteingabe

21. Warum haben Sie sich entschieden, Bücher (um . . . Preis) im traditionellen Handel anstatt im Internet zu kaufen?
    Texteingabe

22. Reihen Sie folgende Attribute nach ihrer Wichtigkeit, weswegen Sie Bücher (um . . . Preis) im traditionellen Handel gekauft haben
    ☐ Verfügbarkeit, sofortige Mitnahmemöglichkeit
    ☐ Bekanntheitsgrad des Geschäfts / des Händlers
    ☐ Atmosphäre im Shop
    ☐ Beratung durch Personal
    ☐ Größe der Produktauswahl
    ☐ Bequemlichkeit (Parkmöglichkeiten, Erreichbarkeit)
    ☐ Service (Lieferung, Rückgabemöglichkeiten)
    ☐ Klientel, soziale Einkaufsgruppe (Gesellschaftsschicht der anderen Kunden)
    ☐ Qualität des Produkts
    ☐ Sicherheit (Zahlung)
    ☐ Privatsphäre
    ☐ Prüfungsmöglichkeit vor dem Kauf (Fühlen; Riechen; Sehen; Anprobieren; ich weiß, was ich bekomme)

23. Reihen Sie folgende Attribute nach ihrer Wichtigkeit, falls Sie Bücher (um . . . Preis) im Internet kaufen würden
    ☐ Lieferzeit
    ☐ Bequemlichkeit (Bestellung von zu Hause, Lieferung)
    ☐ Benutzerfreundlichkeit (Navigation, Ladezeiten) der Website
    ☐ Lieferungsoptionen (Ort, Versicherung)
    ☐ Suche / Information (Vielfalt, Genauigkeit)
    ☐ Sicherheit (Zahlung)
    ☐ Privatsphäre / Anonymität

☐ Bekanntheitsgrad der Website / des Onlinehändlers
☐ Interaktivität (Forum, FAQ-Listen und andere Auswahlhilfen)
☐ Rückgabemöglichkeiten
☐ Qualität des Produkts
☐ Größe der Produktauswahl
☐ Klientel, soziale Einkaufsgruppe (Wer kauft dort sonst noch ein?)

24. Welchen Preis dürfen Bücher (um ... Preis im traditionellen Handel) im Internet haben, damit Sie dort kaufen (inklusive Lieferkosten)?
    Texteingabe

25. Wo kaufen Sie Bücher am liebsten ein?
    ☐ Onlineshop
    ☐ Traditioneller Handel

26. Warum kaufen Sie Bücher (um ... Preis) lieber im Internet anstatt im traditionellen Handel?
    Texteingabe

27. Warum kaufen Sie Bücher (um ... Preis) lieber im traditionellen Handel anstatt im Internet?
    Texteingabe

28. Reihen Sie folgende Attribute nach ihrer Wichtigkeit, weswegen Sie Bücher (um ... Preis) lieber im traditionellen Handel kaufen
    ☐ Verfügbarkeit, sofortige Mitnahmemöglichkeit
    ☐ Bekanntheitsgrad des Geschäfts / des Händlers
    ☐ Atmosphäre im Shop
    ☐ Beratung durch Personal
    ☐ Größe der Produktauswahl
    ☐ Bequemlichkeit (Parkmöglichkeiten, Erreichbarkeit)
    ☐ Service (Lieferung, Rückgabemöglichkeiten)
    ☐ Klientel, soziale Einkaufsgruppe (Gesellschaftsschicht der anderen Kunden)
    ☐ Qualität des Produkts

☐ Sicherheit (Zahlung)
☐ Privatsphäre
☐ Prüfungsmöglichkeit vor dem Kauf (Fühlen; Riechen; Sehen; Anprobieren; ich weiß, was ich bekomme)

29. Reihen Sie folgende Attribute nach ihrer Wichtigkeit, weswegen Sie Bücher (um ... Preis) lieber im Internet kaufen
☐ Lieferzeit
☐ Bequemlichkeit (Bestellung von zu Hause, Lieferung)
☐ Benutzerfreundlichkeit (Navigation, Ladezeiten) der Website
☐ Lieferungsoptionen (Ort, Versicherung)
☐ Suche / Information (Vielfalt, Genauigkeit)
☐ Sicherheit (Zahlung)
☐ Privatsphäre / Anonymität
☐ Bekanntheitsgrad der Website / des Onlinehändlers
☐ Interaktivität (Forum, FAQ-Listen und andere Auswahlhilfen)
☐ Rückgabemöglichkeiten
☐ Qualität des Produkts
☐ Größe der Produktauswahl
☐ Klientel, soziale Einkaufsgruppe (Wer kauft dort sonst noch ein?)

30. Welchen Preis dürfen Bücher (um ... Preis im Internet) im traditionellen Handel haben, damit Sie dort lieber kaufen?
Texteingabe

31. Welchen Preis dürfen Bücher (um ... Preis im traditionellen Handel) im Internet haben, damit Sie dort lieber kaufen (inklusive Lieferkosten)?
Texteingabe

B.5 Demographic

32. Alter in Jahren
☐ 0-15 Jahre
☐ 15-19 Jahre

☐ 20-24 Jahre

☐ 25-29 Jahre

☐ 30-39 Jahre

☐ 40-49 Jahre

☐ 50-59 Jahre

☐ 60-69 Jahre

☐ 70-79 Jahre

☐ 80 Jahre und älter

33. Geschlecht

    ☐ männlich ☐ weiblich

34. Höchste abgeschlossene Ausbildung

    ☐ Pflichtschule

    ☐ Lehre

    ☐ Fachschule

    ☐ AHS / BHS (Matura, Abitur)

    ☐ Hochschule (Universität, Fachhochschule)

35. Stellung im Beruf

    ☐ Schülerinnen und Schüler / Studentinnen und Studenten

    ☐ Lehrling

    ☐ Angestellte / Freier Dienstnehmer

    ☐ Arbeiterinnen und Arbeiter

    ☐ Öffentlich Bedienstete

    ☐ Selbstständig ohne Mitarbeiterinnen und Mitarbeiter

    ☐ Selbstständig mit Mitarbeiterinnen und Mitarbeiter

    ☐ Pension

    ☐ Arbeitslos

36. Wieviele Personen leben ständig in Ihrem Haushalt, Sie selbst und Kinder eingeschlossen?

Texteingabe

37. Wie viele Kinder unter 18 Jahren leben in Ihrem Haushalt?

Texteingabe

38. Familienstand
    ☐ ledig
    ☐ verheiratet / Lebensgemeinschaft
    ☐ geschieden / verwitwet

39. Wohungsumfeld
    ☐ ländlicher Raum
    ☐ kleinstädtischer Raum
    ☐ Großstadt

40. Besitzen Sie ein Auto?
    ☐ Ja ☐ Nein

Appendix C

Sourcecode

```
rm(list=ls())

z=require(plotrix)
z=require(stats)
z=require(mclust)
z=require(MASS)
# deploy on different machines
library(e1071)
taskid=as.integer(Sys.getenv("SGE_TASK_ID")) # jeder knoten


# ------------------------------------------------------------------------
# ------------------------------------------------------------------------
#          S I M U L A T I O N    S E T U P
# ------------------------------------------------------------------------
# ------------------------------------------------------------------------

# set the marketing ranking
# for a certain product
MARKETING = ...



DEBUG=TRUE
MARKETING_NAMES_ONLINE=c("lieferzeit","bequemlichkeit","usability","lieferoptionen",
                         "suche / info","sicherheit","privatshaere","name shop",
                         "interaktivitaet","rueckgabemoeglichkeit","qualitaet",
                         "auswahl","klientel")
MARKETING_ONLINE_LEN=length(MARKETING_NAMES_ONLINE)
MARKETING_NAMES_OFFLINE=c("mitnahme_off","name geschaeft_off","atmosphaere_off",
                          "beratung_off","auswahl_off","bequmlichkeit_off",
                          "service_off","klientel_off","qualitaet_off",
                          "sicherheit_off","privatshaere_off",
```

```
                              "pruefungsmoeglichkeiten_off")
MARKETING_OFFLINE_LEN=length(MARKETING_NAMES_OFFLINE)
# sum on ALL marketing aktivities must not exeed 1 (budgetconstraint)
MARKETING_NAMES=c(MARKETING_NAMES_OFFLINE,MARKETING_NAMES_ONLINE)
names(MARKETING)=c(MARKETING_NAMES_OFFLINE,MARKETING_NAMES_ONLINE)
MARKETING_OFFLINE=MARKETING[c(1:MARKETING_OFFLINE_LEN)]
MARKETING_ONLINE=MARKETING[c((MARKETING_OFFLINE_LEN+1):
                              (MARKETING_OFFLINE_LEN+MARKETING_ONLINE_LEN))]
MARKETING_LEN=length(MARKETING)

# to calculate marketing efficiency
MARKETING_OFFLINE_MULTI=MARKETING[c(1:MARKETING_OFFLINE_LEN)]%*%
                              MARKETING[c(1:MARKETING_OFFLINE_LEN)]
MARKETING_ONLINE_MULTI=MARKETING[c((MARKETING_OFFLINE_LEN+1):
                              (MARKETING_OFFLINE_LEN+MARKETING_ONLINE_LEN))]%*%
                              MARKETING[c((MARKETING_OFFLINE_LEN+1):
                              (MARKETING_OFFLINE_LEN+MARKETING_ONLINE_LEN))]

# weight of marketing efficiency on switching distribution
MARKETING_SHAPEWEIGHT=4
# weight of channel preferences
MARKETING_OFFSETWEIGHT=0.2

RESERV_OFF=c(offp[1],offp[2])
RESERV_ON=c(onp[1],onp[2])

SWITCH_ON_OFF=list();SWITCH_OFF_ON=list()
SWITCH_ON_OFF[[1]]=c(onoff[1],onoff[2]);
SWITCH_OFF_ON[[1]]=c(offon[1],offon[2])
SWITCH_ON_OFF[[2]]=c(onoff[1],onoff[2])
SWITCH_OFF_ON[[2]]=c(offon[1],offon[2])

# offset. pecuniary advantage of a channel
# within a firm (intrafirm)
SWITCH_INTRA_OFFSET=list()
SWITCH_INTRA_OFFSET[[1]]=c(offline_compet,online_compet)
SWITCH_INTRA_OFFSET[[2]]=c(offline_compet,online_compet)

# switching between firm1 and firm 2
# equal prices show no effect
SWITCH_F_OFF_OFF=list();SWITCH_F_ON_ON=list()
SWITCH_F_OFF_OFF[[1]]=c(4,4);SWITCH_F_ON_ON[[1]]=c(4,4)
SWITCH_F_OFF_OFF[[2]]=c(4,4);SWITCH_F_ON_ON[[2]]=c(4,4)
SWITCH_F_OFF_ON=list();SWITCH_F_ON_OFF=list()
SWITCH_F_OFF_ON[[1]]=c(offon[1],offon[2])
SWITCH_F_ON_OFF[[1]]=c(onoff[1],onoff[2])
SWITCH_F_OFF_ON[[2]]=c(offon[1],offon[2])
SWITCH_F_ON_OFF[[2]]=c(onoff[1],onoff[2])

# offset: pecuniary advantage of a certain channel
```

```
# between different firms
SWITCH_OFF_OFF_OFFSET=c(0,0)
SWITCH_ON_ON_OFFSET=c(0,0)
SWITCH_OFF_ON_OFFSET=c(offline_compet, offline_compet)
SWITCH_ON_OFF_OFFSET=c(online_compet, online_compet)

#consumer offline / online
CONS=c(10000,10000)

# offline / online marginal costs
COSTS=list()
COSTS[[1]]=c(0.1,0.1)
COSTS[[2]]=c(0.1,0.1)

# evolutionary strategies - parameter
ES_MU=1000
ES_LAMBDA=ES_MU * 3
ES_MUTATIONRATE=0.4
# mutation = +/- stddev*ES_MUTATIONRANGE
ES_MUTATIONRANGE=0.5
ES_CROSSOVERRATE=0.15
# minimal change from one generation to next->if lower: stop
ES_THRESHOLD=0.0001
# maximal number of generation if higher -> stop
ES_MAX_GENERATIONS=1500
# min price if price of an element undercuts 0
ES_MINPRICE=0.00001
# max price if price of an element exceeds 1
ES_MAXPRICE=0.99999

MARKETING_MAX_INVESTMENT=matrix(rep(c(MARKETING_OFFLINE,MARKETING_ONLINE),ES_MU),
                                ncol=MARKETING_LEN, byrow=T)
MARKETING_MAX_INVESTMENT2=matrix(rep(c(MARKETING_OFFLINE,MARKETING_ONLINE),ES_MU*4),
                                 ncol=MARKETING_LEN, byrow=T)

set.seed(20391)

##############################################################################
#
#   F U N C T I O N S
#
##############################################################################
# normalize marketing investments to meet budget constraint
normalizeMarketing=function(gen) {
  # normalize values
  mark=gen[,c(MARKETING_NAMES),drop=F]
  mark=mark/(apply(mark,1,sum))
  # trunc overinvestments (overinvestments are LOST)
  mark=pmin(MARKETING_MAX_INVESTMENT[c(1:dim(mark)[1]),],mark)

```

```
  gen[,c(MARKETING_NAMES)]=mark
  return(gen)
}

# calculate consumer base due to pricing and marketing
calcConsumer=function(pb,po,pb_c,po_c,switching,firm) {
  .nno1=0;.nnb1=0;
  .nno2=0;.nnb2=0;
  .nnb1_c=0;.nno1_c=0
  .nnb2_c=0;.nno2_c=0
  firm_c=ifelse(firm==1,2,1)

  .offline_id=pb<pb_c
  .nnb2=ifelse(.offline_id,CONS[1]*(1-pbeta(pb,RESERV_OFF[1],RESERV_OFF[2])) -
                          CONS[1]*(1-pbeta(pb_c,RESERV_OFF[1],RESERV_OFF[2])),0)
  .nnb1=ifelse(.offline_id,(CONS[1]*(1-pbeta(pb_c,RESERV_OFF[1],RESERV_OFF[2])))/2,
                          (CONS[1]*(1-pbeta(pb,RESERV_OFF[1],RESERV_OFF[2])))/2)
  .nnb1_c=ifelse(.offline_id,(CONS[1]*(1-pbeta(pb_c,RESERV_OFF[1],RESERV_OFF[2])))/2,
                          (CONS[1]*(1-pbeta(pb,RESERV_OFF[1],RESERV_OFF[2])))/2)

  .online_id=po<po_c
  .nno2=ifelse(.online_id,CONS[2]*(1-pbeta(po,RESERV_ON[1],RESERV_ON[2])) -CONS[2]*
                          (1-pbeta(po_c,RESERV_ON[1],RESERV_ON[2])),0)
  .nno1=ifelse(.online_id,(CONS[2]*(1-pbeta(po_c,RESERV_ON[1],RESERV_ON[2])))/2,
                          (CONS[2]*(1-pbeta(po,RESERV_ON[1],RESERV_ON[2])))/2)
  .nno1_c=ifelse(.online_id,(CONS[2]*(1-pbeta(po_c,RESERV_ON[1],RESERV_ON[2])))/2,
                          (CONS[2]*(1-pbeta(po,RESERV_ON[1],RESERV_ON[2])))/2)

  # probabilities of NOT-SWITCHING !!!!!!!!!!
  .switchoffon=(1-pbeta((pb-po)+switching[[firm]][["intra_offset"]][,"offline"],
     switching[[firm]][["off_on"]][,1],switching[[firm]][["off_on"]][,2]))
  .switchonoff=(1-pbeta((po-pb)+switching[[firm]][["intra_offset"]][,"online"],
     switching[[firm]][["on_off"]][,1],switching[[firm]][["on_off"]][,2]))
  .switchfoffoff=1
  .switchfoffon=(1-pbeta((pb-po_c)+switching[[firm]][["off_on_offset"]],
     switching[[firm]][["f_off_on"]][,1],switching[[firm]][["f_off_on"]][,2]))
  .switchfonon=1
  .switchfonoff=(1-pbeta((po-pb_c)+switching[[firm]][["on_off_offset"]],
     switching[[firm]][["f_on_off"]][,1],switching[[firm]][["f_on_off"]][,2]))

  # opponent
  .switchoffon_c=(1-pbeta((pb_c-po_c)+switching[[firm_c]][["intra_offset"]][,"offline"],
     switching[[firm_c]][["off_on"]][,1],switching[[firm_c]][["off_on"]][,2]))
  .switchonoff_c=(1-pbeta((po_c-pb_c)+switching[[firm_c]][["intra_offset"]][,"online"],
     switching[[firm_c]][["on_off"]][,1],switching[[firm_c]][["on_off"]][,2]))
  .switchfoffoff_c=1
  .switchfoffon_c=(1-pbeta((pb_c-po)+switching[[firm_c]][["off_on_offset"]],
     switching[[firm_c]][["f_off_on"]][,1],switching[[firm_c]][["f_off_on"]][,2]))
  .switchfonon_c=1
  .switchfonoff_c=(1-pbeta((po_c-pb)+switching[[firm_c]][["on_off_offset"]],
```

```
    switching[[firm_c]][["f_on_off"]][,1],switching[[firm_c]][["f_on_off"]][,2]))

  .nb=.nnb1*.switchoffon*.switchfoffoff*.switchfoffon +
      .nnb2*.switchoffon +
      .nnb1_c*.switchoffon_c*(1-.switchfoffoff_c)*.switchfoffon_c +
      .nno1_c*.switchonoff_c*.switchfonon_c*(1-.switchfonoff_c) +
      .nno1*(1-.switchonoff)*.switchfonon*.switchfonoff+
      .nno2*(1-.switchonoff)

  .no=.nno1*.switchonoff*.switchfonon*.switchfonoff+
      .nno2*.switchonoff+
      .nno1_c*.switchonoff_c*(1-.switchfonon_c)*.switchfonoff_c+
      .nnb1_c*.switchoffon_c*.switchfoffoff_c*(1-.switchfoffon_c)+
      .nnb1*(1-.switchoffon)*.switchfoffoff*.switchfoffon+
      .nnb2*(1-.switchoffon)

  # returns one firm only, since opponent's prices are mean-values!
  return(cbind(.nb,.no))
}

# calculate the efficiency of marketing investments
calcMarketingEfficiency=function(marketing,channel) {
  if (channel==1)
    return(1/MARKETING_OFFLINE_MULTI*MARKETING_OFFLINE%*%marketing)
  else
    return(1/MARKETING_ONLINE_MULTI*MARKETING_ONLINE%*%marketing)
}

# alter switching probabilities due to marketing
alterProbabilities=function(gen1, gen2) {
  anz_tupel=dim(gen1)[1]
  mark=gen1[,c(MARKETING_NAMES_ONLINE),drop=F]
  optimal_online1=apply(mark,1,calcMarketingEfficiency,2)
  # refine for >1 or NaN
  optimal_online1[optimal_online1>1]=1

  mark=gen1[,c(MARKETING_NAMES_OFFLINE),drop=F]
  optimal_offline1=apply(mark,1,calcMarketingEfficiency,1)
  optimal_offline1[optimal_offline1>1]=1

  mark=gen2[,c(MARKETING_NAMES_ONLINE),drop=F]
  optimal_online2=apply(mark,1,calcMarketingEfficiency,2)
  optimal_online2[optimal_online2>1]=1

  mark=gen2[,c(MARKETING_NAMES_OFFLINE),drop=F]
  optimal_offline2=apply(mark,1,calcMarketingEfficiency,1)
  optimal_offline2[optimal_offline2>1]=1
  MY_FRACTION=1

  switching=list()
```

```
switching[[1]]=list()
switching[[1]][["off_on"]]=matrix(rep(cbind(SWITCH_OFF_ON[[1]][1],
    SWITCH_OFF_ON[[1]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
switching[[1]][["on_off"]]=matrix(rep(cbind(SWITCH_ON_OFF[[1]][1],
    SWITCH_ON_OFF[[1]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
switching[[1]][["intra_offset"]]=matrix(rep(cbind(SWITCH_INTRA_OFFSET[[1]][1],
    SWITCH_INTRA_OFFSET[[1]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
colnames(switching[[1]][["intra_offset"]])=c("offline","online")
# changes due to marketing
switching[[1]][["off_on"]]=switching[[1]][["off_on"]]+
    cbind(optimal_offline1,1-optimal_offline1)*MARKETING_SHAPEWEIGHT
switching[[1]][["on_off"]]=switching[[1]][["on_off"]]+
    cbind(optimal_online1,1-optimal_online1)*MARKETING_SHAPEWEIGHT
switching[[1]][["intra_offset"]]=switching[[1]][["intra_offset"]]+
    cbind((-optimal_offline1+optimal_online1)/MY_FRACTION,
    (optimal_offline1-optimal_online1)/MY_FRACTION)*MARKETING_OFFSETWEIGHT

switching[[1]][["f_off_off"]]=matrix(rep(cbind(SWITCH_F_OFF_OFF[[1]][1],
    SWITCH_F_OFF_OFF[[1]][2]),anz_tupel),nrow=anz_tupel,byrow=T)

switching[[1]][["f_off_off"]]=switching[[1]][["f_off_off"]]+
    cbind(optimal_offline1,1-optimal_offline1)*MARKETING_SHAPEWEIGHT

switching[[1]][["off_off_offset"]]=rep(cbind(SWITCH_OFF_OFF_OFFSET[1]),anz_tupel)+
    ((-optimal_offline1+optimal_offline2)/MY_FRACTION)*MARKETING_OFFSETWEIGHT

switching[[1]][["f_on_on"]]=matrix(rep(cbind(SWITCH_F_ON_ON[[1]][1],
    SWITCH_F_ON_ON[[1]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
switching[[1]][["f_on_on"]]=switching[[1]][["f_on_on"]]+
    cbind(optimal_online1,1-optimal_online1)*MARKETING_SHAPEWEIGHT
switching[[1]][["on_on_offset"]]=rep(cbind(SWITCH_ON_ON_OFFSET[1]),anz_tupel)+
    ((-optimal_online1+optimal_online2)/MY_FRACTION)*MARKETING_OFFSETWEIGHT

switching[[1]][["f_off_on"]]=matrix(rep(cbind(SWITCH_F_OFF_ON[[1]][1],
    SWITCH_F_OFF_ON[[1]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
switching[[1]][["f_off_on"]]=switching[[1]][["f_off_on"]]+
    cbind(optimal_offline1,1-optimal_offline1)*MARKETING_SHAPEWEIGHT
switching[[1]][["off_on_offset"]]=rep(cbind(SWITCH_OFF_ON_OFFSET[1]),anz_tupel)+
    ((-optimal_offline1+optimal_online2)/MY_FRACTION)*MARKETING_OFFSETWEIGHT

switching[[1]][["f_on_off"]]=matrix(rep(cbind(SWITCH_F_ON_OFF[[1]][1],
    SWITCH_F_ON_OFF[[1]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
switching[[1]][["f_on_off"]]=switching[[1]][["f_on_off"]]+
    cbind(optimal_online1,1-optimal_online1)*MARKETING_SHAPEWEIGHT
switching[[1]][["on_off_offset"]]=rep(cbind(SWITCH_ON_OFF_OFFSET[1]),anz_tupel)+
    ((-optimal_online1+optimal_offline2)/MY_FRACTION)*MARKETING_OFFSETWEIGHT

switching[[2]]=list()
switching[[2]][["off_on"]]=matrix(rep(cbind(SWITCH_OFF_ON[[2]][1],
    SWITCH_OFF_ON[[2]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
```

```
  switching[[2]][["on_off"]]=matrix(rep(cbind(SWITCH_ON_OFF[[2]][1],
    SWITCH_ON_OFF[[2]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
  switching[[2]][["intra_offset"]]=matrix(rep(cbind(SWITCH_INTRA_OFFSET[[2]][1],
    SWITCH_INTRA_OFFSET[[2]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
  colnames(switching[[2]][["intra_offset"]])=c("offline","online")
  # marketing
  switching[[2]][["off_on"]]=switching[[2]][["off_on"]]+
    cbind(optimal_offline2,1-optimal_offline2)*MARKETING_SHAPEWEIGHT
  switching[[2]][["on_off"]]=switching[[2]][["on_off"]]+
    cbind(optimal_online2,1-optimal_online2)*MARKETING_SHAPEWEIGHT
  switching[[2]][["intra_offset"]]=switching[[2]][["intra_offset"]]+
    cbind((-optimal_offline2+optimal_online2)/MY_FRACTION,
    (optimal_offline2-optimal_online2)/MY_FRACTION)*MARKETING_OFFSETWEIGHT

  switching[[2]][["f_off_off"]]=matrix(rep(cbind(SWITCH_F_OFF_OFF[[2]][1],
    SWITCH_F_OFF_OFF[[2]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
  switching[[2]][["f_off_off"]]=switching[[2]][["f_off_off"]]+
    cbind(optimal_offline2,1-optimal_offline2)*MARKETING_SHAPEWEIGHT
  switching[[2]][["off_off_offset"]]=matrix(rep(cbind(SWITCH_OFF_OFF_OFFSET[2]),
    anz_tupel),nrow=anz_tupel,byrow=T)+((-optimal_offline2+optimal_offline1)/
    MY_FRACTION)*MARKETING_OFFSETWEIGHT

  switching[[2]][["f_on_on"]]=matrix(rep(cbind(SWITCH_F_ON_ON[[2]][1],
    SWITCH_F_ON_ON[[2]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
  switching[[2]][["f_on_on"]]=switching[[2]][["f_on_on"]]+
    cbind(optimal_online2,1-optimal_online2)*MARKETING_SHAPEWEIGHT
  switching[[2]][["on_on_offset"]]=rep(cbind(SWITCH_ON_ON_OFFSET[2]),anz_tupel)+
    ((-optimal_online2+optimal_online1)/MY_FRACTION)*MARKETING_OFFSETWEIGHT

  switching[[2]][["f_off_on"]]=matrix(rep(cbind(SWITCH_F_OFF_ON[[2]][1],
    SWITCH_F_OFF_ON[[2]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
  switching[[2]][["f_off_on"]]=switching[[2]][["f_off_on"]]+
    cbind(optimal_offline2,1-optimal_offline2)*MARKETING_SHAPEWEIGHT
  switching[[2]][["off_on_offset"]]=rep(cbind(SWITCH_OFF_ON_OFFSET[2]),anz_tupel)+
    ((-optimal_offline2+optimal_online1)/MY_FRACTION)*MARKETING_OFFSETWEIGHT

  switching[[2]][["f_on_off"]]=matrix(rep(cbind(SWITCH_F_ON_OFF[[2]][1],
    SWITCH_F_ON_OFF[[2]][2]),anz_tupel),nrow=anz_tupel,byrow=T)
  switching[[2]][["f_on_off"]]=switching[[2]][["f_on_off"]]+
    cbind(optimal_online2,1-optimal_online2)*MARKETING_SHAPEWEIGHT
  switching[[2]][["on_off_offset"]]=rep(cbind(SWITCH_ON_OFF_OFFSET[2]),anz_tupel)+
    ((-optimal_online2+optimal_offline1)/MY_FRACTION)*MARKETING_OFFSETWEIGHT

  return(switching)
}

# calculate sales, profit
calcSales=function(gen1,gen2,firm){
  .switching=alterProbabilities(gen1,gen2)
  .consumer=calcConsumer(gen1[,"offline"],gen1[,"online"],gen2[,"offline"],
```

```
    gen2[,"online"],.switching,firm)
  .sales=.consumer[,1]*gen1[,"offline"] + .consumer[,2]*gen1[,"online"]
  .profit=.consumer[,1]*(gen1[,"offline"]-COSTS[[firm]][1]) +
    .consumer[,2]*(gen1[,"online"]-COSTS[[firm]][2])
  .df=list()
  .df$consumer=.consumer
  .df$sales=.sales
  .df$profit=.profit
  return(.df)
}


###############################################################################
#
#   E V O L U T I O N A R Y     S T R A T E G I E S
#
###############################################################################

############### mutation ######################################################
# new online and offline prices after crossover
# return mutated children
doMutation=function(genpool) {
  anz_tupel=dim(genpool)[1]
  anz_param=dim(genpool)[2]
  # mutation probabilities
  .mutation_row=runif(anz_tupel,0,1)
  mutation_row=.mutation_row
  # these children mutate
  mutation_row[.mutation_row<ES_MUTATIONRATE]=1
  mutation_row[.mutation_row>=ES_MUTATIONRATE]=0

  mutation_matrix=round(matrix(rep(mutation_row,anz_param),ncol=anz_param),4)

  # choose value to mutate
  mutation_col=matrix(runif(anz_tupel*anz_param,0,1),nrow=anz_tupel)
  mutation_matrix=mutation_matrix*mutation_col

  mutation_col_max=apply(mutation_matrix,1,max)
  mutation_col_max[mutation_col_max==0]=1
  mutation_col_matrix=matrix(rep(mutation_col_max,anz_param),ncol=anz_param,byrow=F)

  mutation_matrix[mutation_matrix==mutation_col_matrix]=1
  mutation_matrix[mutation_matrix<1]=0

  mutation_value=apply(genpool,2,var)
  mutation_value=ES_MUTATIONRANGE*sqrt(mutation_value)
  mutation_matrix=mutation_matrix*mutation_value
  mutation_direction=runif(anz_tupel,0,1)
  mutation_direction[mutation_direction<0.5]=-1    # stddev -
```

```
  mutation_direction[mutation_direction>=0.5]=1    # stddev +

  mutation_matrix=mutation_matrix*mutation_direction

  genpool=genpool+mutation_matrix

  # remove outlier
  genpool[genpool<0]=ES_MINPRICE
  genpool[genpool>1]=ES_MAXPRICE
  return(genpool)
}

############### crossover ######################################################
# new online and offline prices after crossover
# generate children: ES_LAMBDA children + parents = result
doCrossover=function(genpool, matingpool) {
  # randomize matingpool (matingpool contains indices!)
  mat_pool_rand1=sample(sample(matingpool))
  # initital children
  genpool_offspring1=genpool[c(mat_pool_rand1),]
  mat_pool_rand2=sample(sample(matingpool))
  genpool_offspring2=genpool[c(mat_pool_rand2),]
  # crossover
  anz_tupel=dim(genpool_offspring1)[1]
  anz_param=dim(genpool_offspring1)[2]
  # crossover probabilities
  .crossover_row=runif(anz_tupel,0,1)
  crossover_row=.crossover_row
  # these children crossover
  crossover_row[.crossover_row<ES_CROSSOVERRATE]=1
  crossover_row[.crossover_row>=ES_CROSSOVERRATE]=0

  crossover_matrix=round(matrix(rep(crossover_row,anz_param),ncol=anz_param),4)

  # select crossover point
  crossover_col=matrix(runif(anz_tupel*anz_param,0,1),nrow=anz_tupel)
  crossover_matrix=crossover_matrix*crossover_col

  crossover_col_max=apply(crossover_matrix,1,max)
  crossover_col_max[crossover_col_max==0]=1
  crossover_col_matrix=matrix(rep(crossover_col_max,anz_param),ncol=anz_param)

  crossover_matrix[crossover_matrix==crossover_col_matrix]=1
  crossover_matrix[crossover_matrix<1]=0
  crossover_matrix=t(apply(crossover_matrix,1,cumsum))
  genpool_offspring_part1=genpool_offspring1*crossover_matrix
  genpool_offspring_part2=genpool_offspring2*(!crossover_matrix)

  new_genpool=genpool_offspring_part1+genpool_offspring_part2

```

```
  return(rbind(genpool,new_genpool))
}

############### stochastic universal sampling ################################
# returns index of surviving items (fitness based selection)
selectFittestParents=function(parents,.length) {
  x_id=order(parents,decreasing = TRUE)
  x_order=rbind(parents)[,x_id]
  x_cum=cumsum(x_order)
  mat_start=runif(1,0,1/.length)
  mat_sel=seq(mat_start,by=1/.length,length.out=.length)
  x_sel=rep(0,.length)
  x_cum=x_cum/x_cum[length(x_cum)]
  x_sel=(mat_sel<x_cum[1])
  x_sel[x_sel==TRUE]=x_id[1]

  for (i in c(2:length(parents))) {
    z=(mat_sel<x_cum[i] &  mat_sel>=x_cum[i-1])
    z[z==TRUE]=x_id[i]
    x_sel=x_sel+z
  }
  # return indices
  return(x_sel)
}



################################################################################
#
#   C A L C U L A T E
#
################################################################################
# at this point only parts of the code are provided
# data fetching and storage seem to be unessential
#

############### scenario loop ##################################################
for (scenarioCnt in c(1:8)) {
  # set up the competitor and the consumers
  # fetch data from the database to estimate distributions and marketing demand
  # set up the opponent (pricing, marketing)
  # initialize genpool for firm 1
  while (generationCnt < ES_MAX_GENERATIONS) {

    generationValues1=calcSales(genpool1,genpool2,1)
    generationValues2=calcSales(genpool2,genpool1,2)

    # start selecting new generation
    mat_pool1=selectFittestParents(generationValues1$profit,ES_LAMBDA)
    new_genpool1=doCrossover(genpool1,mat_pool1)
```

```
    new_genpool1=normalizeMarketing2(new_genpool1)
    new_genpool1=doMutation(new_genpool1)
    new_genpool1=normalizeMarketing2(new_genpool1)
    .rep1=which(new_genpool1[,"offline"]<COSTS[[1]][1])
    new_genpool1[.rep1,"offline"]=COSTS[[1]][1]
    .rep1=which(new_genpool1[,"online"]<COSTS[[1]][2])
    new_genpool1[.rep1,"online"]=COSTS[[1]][2]

    # select fittest to be next step parents
    tmp_gen2=matrix(rep(genpool2[1,],ES_LAMBDA+ES_MU),nrow=ES_MU+ES_LAMBDA,byrow=T,)
    colnames(tmp_gen2)=colnames(genpool2)
    sales1=calcSales(new_genpool1,tmp_gen2,1)

    surviving1=selectFittestParents(sales1$profit,ES_MU)
    genpool1=new_genpool1[surviving1,]
  }
}
```